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U.S. Army
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U.S. Army Environmental Center Environmental Technology Division

FY 96 Annual Report

Innovative Technology Demonstration, Evaluation and Transfer Activities

Report No. SFIM-AEC-ET-CR-97013

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This report is a summary of the Innovative Technology/Technology Transfer Program projects managed by the Environmental Technology Division of the U.S. Army Environmental Center. The report describes the project, participants, results, and requirements of various ongoing innovative technology projects. Points of contact for additional information are given.

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Introduction

This report gives the reader an opportunity to review information on environmental technology projects in progress at the U.S. Army Environmental Center (USAEC) Environmental Technology Division (ETD). It is intended to provide summaries of our projects so you may better understand the work in progress and this division's capabilities. A brief review of the program partners listed in the Appendix indicates that ETD is working with all Services, other Federal agencies, non-Federal agencies, and private-sector industries. Each of these partners may be able to identify and validate environmental technologies for use outside the Department of Defense (DoD).

Emerging environmental technology provides additional tools for the installation commander to support Army readiness and mission accomplishment through environmental compliance and protection.

Environmental Technology Division

The ETD is chartered to provide technical support and guidance in the transfer of emerging technology throughout the U.S. Army. The Environmental Technology Implementation Program (ETIP) is focused on the identification, validation, and fielding of technologies which can support the overall environmental programs of the U.S. Army. As a result of past ETD projects, the Army is using:

- ***Tri-Service Site characterization methods which avoid extensive drilling and digging using the Site Characterization and Analysis Penetrometer System (SCAPS)***
- ***Transportable Hot Gas Decontamination***
- ***Composting technologies to clean explosives-contaminated soil***

ETD conducts demonstrations of new and innovative environmental technologies, and transfers successful technologies to the field. Our experienced scientists and engineers, with expertise in all environmental areas, are organized into functional teams, such as cleanup, conservation, compliance, and pollution prevention. They provide the support necessary to move the technology from the laboratory to the field.

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Environmental Technology Successes

A look at several fielded technologies illustrates ETD's capabilities and accomplishments. This discussion highlights some past successes.

Tri-Service Site Characterization and Analysis Penetrometer System (SCAPS)

The purpose of this project is to develop, demonstrate, and transition a rapid means of characterizing subsurface contamination and to reduce the number of monitoring wells and soil borings at a site, thus reducing traditional site characterization costs.

The SCAPS system is a truck-mounted cone penetrometer system. Attached to the penetrometer is one of several sensor probes. The sensor collects information on the sub-surface contaminants while relaying information to the surface for analysis and interpretation. SCAPS provides an ability to collect and analyze field data faster than traditional methods. Because the SCAPS system costs less than conventional sampling techniques, more samples can be taken on a site in a greater period of time, providing the definition of the contamination boundaries faster. An additional benefit of SCAPS is the reduced quantity of investigation-derived wastes generated as part of the site characterization. SCAPS is fielded and has been used on Army, Navy, Air Force, DOE and EPA sites. The Army, Navy, DOE and EPA have SCAPS systems.

Application of innovative SCAPS field screening technologies will result in faster, more detailed site characterization at considerably lower costs than current methods. A cost/benefit analysis conducted by DOE (DOE report #LAUR-91-4016) indicates that , in a site investigation alone, 25 to 35 percent cost avoidance can be realized with SCAPS Laser-Induced Fluorescence (LIF) technology (EPA CSCT report in publication). In addition, because SCAPS can delineate the extent of the subsurface contamination more accurately than with widely spaced monitoring wells, the remediation costs will also be significantly reduced.

USAEC leads a tri-service effort to enhance existing cone penetrometry with chemical sensors to detect and delineate site contamination. Current capabilities include petroleum, oil, and lubricant (POL) screening, identification of stratigraphy, soil resistivity measurements, and micro-well installation. These capabilities have successfully been evaluated by the EPA Superfund Innovative Technologies Evaluation (SITE) program and the EPA Consortium for Site Characterization Technologies (CSCT), is currently validating them. The SCAPS system has been evaluated under the EPA SITE program. Phase 2 validation of the technology under the EPA-led Consortium for Site Characterization Technologies (CSCT) was completed in the first quarter of FY 1996.

The POL sensor technology, using the LIF probe, was patented and licensed for commercial production and marketing and has completed field demonstrations successfully at many DoD and DOE site such as Germany, and is currently characterizing sites throughout Europe. SCAPS can be used at all DoD installations, Formerly Used Defense Sites (FUDS), Department of Energy (DOE), Department of Interior (DOI), and EPA-EMSL sites.

Additional SCAPS probes to detect heavy metals, Volaitile Organic Compounds (VOCs), and explosives are available. A brief description of each follows.

Metals are detected using one of two methods X-ray Fluorescence and Laser-induced Breakdown Spectroscopy. The X-ray Fluorescence sensor causes metals, above or below the water table, to emit a unique fluorescent signature which is analyzed above ground. Laser-induced Breakdown Spectroscopy quantifies metal concentrations by causing laser-induced plasma emissions. Spectrographic analysis is conducted above ground.

VOCs are identified using two different methods, Hydrosparge VOC Sensor Probe and Thermal Desorption VOC Probe. The Hydrosparge VOC Sensor Probe creates a temporary monitoring well for an in situ sampler to strip the VOCs from groundwater and return them to the surface for real-time analysis by an on board Ion Trap Mass Spectrometer (ITMS). The Thermal Desorption VOC Probe pushes to a desired depth and collects a known volume of soil. Heat is applied, contaminant vapors are purged and transported to the surface for desorbtion and analysis using portable ITMS. The soil plug is ejected and the sample chamber is purged. This process can be repeated at lower depths.

For explosives detection, explosives materials are identified as the probe is pushed into the ground. Soil classification and contamination vs. depth are collected during extraction. The in-probe chemical and geophysical sensors are monitored continuously through an umbical.

Certification of the various probes is executed on a state-by-state basis. The state of California has certified the LIF technology. Reciprocity with other states is being pursued through the Interstate Technology Regulatory Cooperation (ITRC). Certification with the state of California is currently pending for the VOC sensors, as well as reciprocity with other states through the ITRC. Sensors/samplers are also being developed to detect explosives, metals and radionuclides in a coordinated effort with DOE and EPA.

Transportable Hot Gas Decontamination

The ETD conducted a Transportable Hot Gas Decontamination demonstration for explosives-contaminated equipment. The technology's feasibility was shown at the Hawthorne Army Ammunition Plant, Nevada, in 1990.

This technology offers a cost-efficient alternative to open burning/open detonation -- the current underground piping decontamination method. In this process, hot gas technology equipment generates controlled emissions, reduces personnel hazards, allows a quality control/quality assurance program, and allows some reuse of decontaminated materials. That material, which cannot be reused, can be disposed of as scrap material.

There may also be some utility for decontaminating process equipment, scrap materials contaminated with chemical agents, or other hazardous materials encountered during a remediation project. The Hot Gas Decontamination process applies to any suitable size piping or process equipment with internal surfaces that are hard to reach using conventional methods.

Since the first demonstration, commercial components were identified and procured to construct a demonstration system which can be easily constructed.. Following a demonstration at the Alabama Army Ammunition Plant in 1995, the equipment was modified to improve operational performance and fitted with a continuous emissions monitoring system.

Under a project funded by the Industrial Operations Command (IOC), Rock Island, the unit is now in operation at the Newport Chemical Depot, decontaminating piping and equipment from the TNT plant prior to sale as surplus. The effort is scheduled to take place before the close of 1998.

Composting Technologies

This process uses naturally occurring microorganisms to degrade organic waste. In composting, a controlled biological process, microorganisms convert biodegradable hazardous material to innocuous, stabilized by-products, typically at elevated temperatures between 50 ^{0}C and 65 ^{0}C. The increased temperatures result from heat produced by indigenous microorganisms as they degrade the organic material in the waste. The contaminanted soils are mixed with bulking agents and organic amendments such as wood chips and animal manures, and vegetable wastes to enhance the porosity of the mixture and provide a food source for the microorganisms. Maintaining moisture content, pH, oxygenation, temperature, and the carbon-to-nitrogen ratio achieves maximum degradation efficiency. At the end of the process, an organics-rich compost remains. This material can then be placed back onto the contamination site, providing a very fertile soil for revegetation.

Composting has become a cost-effective alternative for the USAEC to cleanup soils containing TNT, RDX, and HMX. The remediation cost depends on several factors including type and level of contamination, available organic amendments, type of composting system, and quantity of contaminated soil at the site. This has been proven to be an effective alternative to treating explosive-contaminated soils.

As the Single Item Manager for DoD conventional munitions, the Army must be able to dispose of Propellants/Explosives/Pyrotechnics production wastes. Open Burning is not permitted in several states and is expected to be banned nationally in the future. Open detonation is also the least acceptable form of disposal because of uncontrolled pollution by-products. One very successful program has been the composting of nitrocellulose (NC) fines.

Manufacturing NC, a highly-substituted cellulose fiber used as a propellant, produces out-of-specification NC fines. Historically, NC fines have been discarded by discharge into lagoons. However, this practice is no longer acceptable. Several methods of rendering NC fines inert have been investigated in the past with only limited success. Previous USAEC studies indicate composting may be a feasible option for disposal of NC fines. Regulatory requirements for the disposal of NC fines are undefined. While NC fines are not toxic substances, they are reactive. In order to dispose of NC fines, their reactivity needs to be reduced. Composting has been shown to render NC fines inert and results in a useful soil amendment.

Radford Army Ammunition Plant (RAAP), Virginia, and Badger Army Ammunition Plant (BAAP), Wisconsin, have collected approximately 1.5 million pounds of excess NC which is stored in waste water holding tanks, combined. Even though this NC is considered product, “gun cotton” and can potentially be used, no market currently exists for it. This is primarily due to different NC blends mixing in the discharge water settling ponds. The market for this "gun cotton" is limited and the presence of other contaminants in the NC (i.e. rust, trash, etc.) limits its market potential.

An evaluation of various options for recovering, treating and disposing of NC in the manufacturing wash streams at RAAP indicated that biological treatment may provide a feasible alternative for the disposal of waste NC fines. A field demonstration at BAAP determined that composting can biologically degrade the NC fines in soils. Significant progress also has occurred in composting development to remediate soils containing explosives.

Viable compost mixtures have been identified that include the necessary biodegradable substrate and bulking agents to promote microbial metabolic activity for the degrading of NC fines. A safety hazards analysis of the NC fines/compost mixtures was performed to determine the quantity of NC fines that can be placed in a compost pile that will preclude flame and shock propagation. Also, sensitivity testing was conducted to determine the response of various NC fines concentrations and amendments to impact, friction, and electrostatic discharge.

A hazards analysis, preceding a pilot NC fines composting demonstration, determined the reactivity of a compost pile consisting of pure NC fines, compost amendments, and moisture, and evaluated the regulatory, logistical, and economic feasibility of composted NC fine disposal.

Based on the regulatory and logistical assessments, NC fines composting is feasible, however, economically it is more expensive than other potential disposal methods. Further investigation of less expensive NC fines disposal methods should be investigated prior to composting demonstration.

Composting offers an alternative treatment technology for the following:

- Remediation of soils contaminated with NC fines,
- Disposal of NC fines stored at Army facilities, and
- Disposal of NC fines generated from the production of nitrocellulose.

Technology Transfer Activities

ETD Participates in a variety of conferences and other forums to share information with potential users. Three conferences that USAEC hosts are highlighted.

- *Tri-Service Environmental Technology Workshop - 10 - 12 June 1997*
- *Tri-Service Environmental Technology Workshop 1998*
- *UXO Forum 1997, 28-30 May 1997*

Tri-Service Environmental Technology Workshop - 10 - 12 June 1997

The Tri-Service Environmental Technology Workshop in St. Louis, Missouri, offers a training forum for technical exchange and interaction on environmental technology strategies, initiatives, demonstrations, and products. The Tri-Service Environmental Support Centers Coordinating Committee Presentations focus on mature technologies that are of timely interest to participants, emphasizing on those technologies that are "field ready," currently being demonstrated, or have been demonstrated. The workshop provides effective information dissemination across the Armed Services, reducing the possibility of individual services duplicating efforts. Combining what could be three conferences into one reduces personnel travel expenses and time from the office.

USAEC hosts the workshop and the organizational committee chair. The organizational committee consists of one individual from each Service environmental center and Service Environment, Safety and Occupational Health (ESOH). The committee's main role is to select abstracts for platform presentation. The balance of the effort is handled by AEC and the support contractor, Science and Technology Corporation.

Tri-Service Environmental Technology Workshop 1998

USAEC is expected to continue as the hosting agency for the Workshop and organizational committee chair. Invitations will again be sent to the respective offices for committee selection.

UXO Forum 1997, 28-30 May 1997

USAEC is producing and hosting UXO Forum 1997, in Nashville, Tennessee. In a concerted effort to bring together the best minds from all corners of the world, UXO Forum 1997 will feature the most diverse audience ever assembled to address technology, policy, and regulatory issues. Each participant will hopefully acquire a greater understanding of UXO-related issues, how they affect our world today, and the implications for the 21st century.

The conference is Sponsored by the U.S. Department of Defense Explosives Safety Board (DDESB), and is hosted by the USAEC, in cooperation with:

U.S. Army Corps of Engineers - Huntsville Center
U.S. Army Project Manager for Non-Stockpile Chemical Material
Naval Explosive Ordnance Disposal Technology Division
U.S. Air Force / Wright Laboratory
National Association of Ordnance and Explosive Waste Contractors

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Annual Report Structure

In order to enable the user to locate ongoing projects based on current installation level requirements, this Annual Report is organized by the following environmental categories:

Air Pollution
Analytical Methods
Characterization
Conservation
Other Environmental Areas
Soil
Solid Waste
Training
Unexploded Ordnance
Water and Wastewater

Each of the project descriptions is organized into several sections listed below. When not applicable, the section heading is omitted for that technology project.

Purpose	What problem does the project address?
Benefits	The benefits which will result from the project.
Technology Users	Who will use the technology?
Background	Background for the technology and the problem. How does the technology work.
Description	Description of the technology or approach.
Applicability	Which environmental research and development requirements does this project (from the 1993 Andrulis report)
Accomplishments and Results	To date, what results have been achieved?
Limitations	Limitations of the technology which might affect the deployment or use
Resource Support	How is this project funded?
Follow-On Program Requirements	What additional requirements are anticipated?
Point of Contact	Primary contact (phone and e-mail address are provided in the appendix).
Program Partners	Organizations that are participating in the project (a consolidated list of partners is provided in the appendix).
Publications	Selected publications relating to the project.
Appendix	Environmental Technology Division Personnel List (Name, phone, e-mail, fax) and address/web site/hotline Program partners Acronyms

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ENVIRONMENTAL TECHNOLOGY PROGRAMS and PROJECTS

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AIR POLLUTION

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Low Volatile Organic Compound Chemical Agent Resistant Coating Demonstration

Protective coatings developed for Army-unique requirements, such as camouflage and chemical agent resistance, must achieve rigorous performance standards while complying with Federal and state air pollution laws. The Army needs coatings which will protect soldiers in wartime and protect the environment in peace. Low VOC coatings will accomplish both requirements.

PURPOSE

To develop a water-based Chemical Agent Resistant Coating (CARC) with a Volatile Organic Compound (VOC) level of 1.5-1.8 lbs/gal and successfully field test it. This demonstration will apply a water reducible CARC to Army vehicles and test its durability, so that the Army can change its current specification and allow a less hazardous formulation to be used.

BENEFITS

Water reducible CARC will cut VOC emissions by about 48%. A water reducible CARC with a VOC of 1.8 lbs/gal can save at least four million pounds of VOCs per year in the application of the coating.

TECHNOLOGY USERS

Army, Air Force, Marines, and Navy.

BACKGROUND

Most Army vehicles and equipment are painted with a special paint that is chemical agent resistant. This paint is very high in solids and VOC content, and has required a solvent carrier to apply the paint.

Current CARC releases 3.5 lbs/gal of VOCs during application. Federal and local regulations, resulting from the Clean Air Act (CAA), restrict the amount of VOCs emitted during application of the coating. As more stringent VOC regulations spread across the nation, more and more facilities will be unable to use the existing CARC without installing expensive air scrubbing systems.

DESCRIPTION

This demonstration will apply a water-based CARC to Army vehicles and test its durability, so that the Army can change its current specification and allow a less hazardous formulation to be used.

APPLICABILITY

Andrulis Report Requirement:

- 3.2.a - Improved Chemical Agent Resistant Coating Techniques (pollution prevention)

CAA

OSHA

ACCOMPLISHMENTS AND RESULTS

The Army Research Laboratory has successfully developed a water reducible CARC which has passed all agent tests for the colors green, brown, black, and desert tan.

The U.S. Army Environmental Center's Environmental Technology Division was host to a meeting discussing the possibility of incorporating the Navy and Marine Corps into a multi-service field test plan for the low VOC CARC project.

Representatives from the Army, Marine Corps, and Navy agreed to work together on this project using one paint manufacturer, two painting venues, and conducting numerous field tests evaluating the new CARC paint.

Spraying tanks and vehicles should begin in 1997 at Letterkenny Army Depot, Pennsylvania.

RESOURCE SUPPORT

For FY 1996, this program was supported by VENC funds.

FOLLOW-ON PROGRAM REQUIREMENTS

- The water reducible CARC will be field tested at Depots before being approved for Depot use. Once the final specification is completed, Depots will be able to use the water-reducible CARC.
- Start spraying panels for agent testing and begin vehicle spraying.
- Finalize the draft specification for the water-reducible CARC.
- Begin working on manuals for the new CARC.
- Begin final test evaluation using original equipment manufacturers chosen earlier by the Army, Marines, and Navy.

POINT OF CONTACT

Peter Stemniski

PROGRAM PARTNERS

U.S. Army Environmental Center

U.S. Army Research Laboratory Coatings Research Team

Reduction of Hazardous Air Pollution Emissions from Electroplating Operations

Electroplating operations support Army manufacturing and maintenance requirements by protecting weapons and support systems surfaces. Electroplating operations often release quantities of hazardous air pollutants. To maintain operation functionality, these releases must be controlled.

PURPOSE

To develop venturi/vortex scrubber technology for controlling/recycling chromium electroplating emissions. This process will save money and pollute less than conventional technologies.

BENEFITS

A venturi/vortex scrubber will save money and pollute less than conventional technologies. While conventional technologies use extensive ventilation systems to pull emissions away from the plating solution and treat them downstream, the venturi/vortex scrubber pulls the liquid particulate emissions back into the plating solution to be recycled. It also prevents emissions by pulling liquid containing bubbles of the byproduct gases down the vortex drains. Capturing these gasses before they reach the surface greatly reduces the emissions generated. Recirculating the plating solution also eliminates the need for additional tank circulation.

TECHNOLOGY USERS

Chromium electroplating and anodizing is used extensively DoD wide. Currently, the Army has seven, the Navy has eight, and the Air Force has five installations with such operations. In the past, more operations existed, but current stringent regulations have forced many installations to close their operations.

BACKGROUND

Chromium has a combination of qualities that are very difficult to substitute, such as hardness, high reflectance, high corrosion resistance, low coefficient of friction, high heat conductivity, and excellent wear resistance. Because of these properties, chromium electroplating has played an important role in coating military hardware and armament. Unfortunately, electroplating and chromium anodizing operations create hazardous air pollutants in the form of hexavalent chromium. The inefficiency of the process creates byproduct gases that rise to the plating surface, creating a chromic acid mist above the electroplating tanks. Conventional technologies for controlling this pollutant are end-of-pipe control devices, such as packed bed scrubbers and composite mesh screens. These devices are expensive, noisy, and use large amounts of energy and water. The end result is that an air pollution problem is turned into a water pollution problem that must be treated.

DESCRIPTION

While conventional technologies use extensive ventilation systems to pull emissions away from the process and treat them downstream, the venturi/vortex scrubber pulls the liquid particulate emissions back into the plating solution to be recycled. The device consists of a series of drains inside the plating tank that draws plating solution down by gravity where the liquid particles are scrubbed by the plating solution through several turns and bends. The gas/liquid mixture flows into a separate vessel to be separated. The liquid is recycled back to the plating tank while the gases are purged through the secondary filter/condensers to remove any remaining particulates. It also prevents emissions by pulling liquid containing bubbles of the byproduct gases down the vortex drains. Capturing these bubbles before they reach the surface where they burst greatly reduces the emissions generated. Recirculating the plating solution also eliminates the need for additional

tank circulation. Conventional air circulation promotes emission generation by contributing additional bubbles. The entire device is located inside the plating tank with the exception of the liquid recycle pump and the secondary filters. It is intended to replace conventional emission control technologies.

This technology will be installed in one chromium electroplating tank at each of the demonstration sites: Marine Corps Logistics Base (MCLB) (Albany, GA) and Hill Air Force Base. At each site, the installation and operation will involve personnel employed by the demonstration site. Once installed, normal production will begin and the device's performance evaluated. The demonstrations will confirm the technology's ability to control emissions to regulatory levels without affecting plating quality and operational practices. A second demonstration is necessary to confirm the technology's performance. The test plan will evaluate plating quality while sampling ambient air and air emissions, all performed during normal production operation. The final test plan will be approved by USEPA before testing begins. Records of costs incurred for the design, installation, and operations will be kept to predict future implementation costs. Because this device offers a large potential energy savings, wastewater treatment, and chromium recovery, a pollution prevention evaluation will be performed to quantify the benefits.

APPLICABILITY

Andrulis Report Requirement:

- 3.b. Compliance-Emission Reduction

ACCOMPLISHMENTS AND RESULTS

- Design complete and installed at Cherry Point Naval Aviation Depot.
- Testing complete at Cherry Point Naval Aviation Depot.
- Design complete and installed at Hill Air Force Base.
- Testing complete at Hill Air Force Base.
- Pollution Prevention analysis complete.
- Final Report complete.
- Technology Transfer Package complete.
- USEPA Compliance requirements approved.

RESOURCE SUPPORT

For FY96, this program was supported by the Environmental Security Technology Certification Program (ESTCP).

POINT OF CONTACT

Louis Kanaras

PROGRAM PARTNERS

U.S. Army Environmental Center

U.S. Environmental Protection Agency

Remediation of Air Streams Contaminated with Trichloroethylene Using Biofiltration at Anniston Army Depot

Air stripping is an effective method of eliminating volatile compounds from water. Following stripping, the volatile compounds must be controlled to prevent release into the atmosphere. Biofiltration provides effective and total treatment at reasonable costs. Biofiltration of TCE contaminated air streams can destroy such air contaminants and not create secondary waste streams. Biofiltration allow depot operations to support DoD operations at lower costs.

PURPOSE

To demonstrate biofiltration's effectiveness to destroy trichloroethylene (TCE) removed from groundwater on a production scale system at Anniston Army Depot (ANAD). The system could be adapted to other industrial operations which produce a solvent contaminated air stream.

BENEFITS

Biofiltration will destroy the contaminant and not produce a secondary waste stream. Early economic evaluations predict that biofiltration will be less expensive than Granular Activated Carbon (GAC).

TECHNOLOGY USERS

Any DoD operation having a solvent air discharge.

BACKGROUND

Packed column air strippers are currently in use at five Army installations and several Air Force bases. Discharge of stripped TCE and other chlorinated solvents to the atmosphere may be prohibited in the future. Capture on GAC is effective, but expensive. Some of the existing air stripper systems discharge to the air which may be prohibited with the new air regulations, and some capture the off gas on GAC. Biofiltration offers the ability to destroy the air contaminants without producing a secondary waste stream.

DESCRIPTION

The biofilter system is an upscale version of a three cubic feet per minute (CFM) system operating at the Tennessee Valley Authority (TVA) for the past three years testing different volatile compounds. The system uses propane gas as the co-substrate to feed the microorganisms, alternately feeding propane and TCE or other solvents. This system will handle methylene chloride and other compounds that are toxic to methanotrophic systems. The filter bed is composed of pelletized composted chicken litter, pine bark, and chopped kenef with pulverized limestone as a buffering agent. The bed at TVA has operated for three years with no addition of materials or changes.

The project consists of three phases: design, installation, and testing. The design phase will produce the design for and procure a system to treat 100 CFM. The installation phase will install the system at one of the Anniston Army Depot's air stripper systems. The treatment phase will include biofilter start up, acclimation, and operation for approximately 14 months. System acclimation will require approximately six weeks once the bed is innoculated with the microorganisms.

The operational period will allow for testing all system parameters such as varying the contaminant concentration in the feed air stream, the most effective sequencing of the propane gas feed and the contaminant air stream, excess moisture and dry conditions in the biofilter, winter to summer temperature extremes, and the degree to which the system can be automated eliminating on-site personnel other than for

routine maintenance checks.

APPLICABILITY

Andrulis Report Requirement:

- 1.2.c Solvents in Groundwater

ACCOMPLISHMENTS AND RESULTS

- The test plan and safety plan have been prepared and approved.
- The equipment design has been completed, the equipment procured and assembled, and the system installed at Anniston Army Depot.
- The system was ready to be innoculated in November 1996 when Anniston Depot personnel notified TVA that EPA was going to conduct an installation groundwater dye test and that all pumps would be stopped until sometime in Spring 1997.

RESOURCE SUPPORT

DERA provided support for this project.

FOLLOW-ON PROGRAM REQUIREMENTS

- Inoculate system and begin organism acclimation.
- Begin system testing and continue for 14 months. Complete testing and prepare draft technical report.

POINT OF CONTACT

Wayne Sisk

PROGRAM PARTNERS

U.S. Army Environmental Center

Tennessee Valley Authority

Anniston Army Depot, Alabama

ANALYTICAL METHODS

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Analysis and Reactions of Degradation Products of Sulfur Mustard in the Environment

Soldiers and civilians working at or near sites which may contain toxic sulfur mustard must be protected from the degradation products.

PURPOSE

To develop and evaluate a sulfur mustard (thiodiglycol) potential fate model in soil and to determine the degradation kinetics factors involved in the process.

BENEFITS

Understanding the degradation process will allow for optimum decisions regarding remediation of sites contaminated with sulfur mustard. This will result in decisions which protect the environment and conserve available resources.

TECHNOLOGY USERS

Pollution Prevention workers, cleanup personnel, soldiers, etc.

BACKGROUND

The U.S. Army Environmental Center has been tasked to identify and cleanup contaminants found on or near Army installations. Some of these contaminants result from past or current manufacturing, testing, storing, and disposing of munitions containing chemical warfare agents. Soil and groundwater near these operational sites may contain chemical warfare agents and their degradation products.

DESCRIPTION

Sulfur Mustard's first derivative, Thiodiglycol (TDG), is oxidized to Thiodiglycol mono-acid (TDGMA) and Thiodyglycol acid (TDGA) in soils. The mechanism is consistent with biological oxidation.

APPLICABILITY

Andrulis Report Requirements:

- 1.1.a Develop Improved Field Analytical Techniques
- 1.1.i Standard Analytical Methods for Army-Unique Compounds
- 1.2.b Organics in Groundwater
- 1.3.h Determine Natural Attenuation Rates of Army-Unique Compounds
- 1.5.a Chemical Warfare Material Fate/Transport Prediction

ACCOMPLISHMENTS AND RESULTS

Briefing package available. Both TDG and TDGA have low adsorptivity to soils and therefore are expected to be highly mobile.

FOLLOW-ON PROGRAM REQUIREMENTS

The technology must apply to a full range of degradation products, but this list of products must be determined.

POINT OF CONTACT

Tony Perry

PROGRAM PARTNERS

U.S. Army Environmental Center

University of Delaware, Department of Civil and Environmental Engineering.

PUBLICATIONS Final Report and briefing package available.

Toxicity Studies for Biotreatment of Explosives-Contaminated Soils

Soldiers and civilians working at or near sites with soils contaminated with explosives need to be protected. This study evaluated the use of popular toxicity tests to evaluate the effectiveness of explosives biotreatment.

PURPOSE

To demonstrate and evaluate new bioremediation technologies.

BENEFITS

Enhanced understanding of the capability of innovative biotechnologies to minimize/reduce the toxicity, mobility, and volume of explosives contaminants.

TECHNOLOGY USERS

Army and other DoD installations which contain areas of explosives-contaminated soils.

BACKGROUND

It is estimated that the U.S. Army has some 40 installations requiring cleanup of explosives-contaminated soils. Currently, regulatory agencies only approve incineration and composting as decontamination technologies. Incineration was commonly accepted by the public in the late 1980's, but this acceptance is now declining. Composting costs can also be high due to the necessary amendments needed for the composting process. For these reasons the Army has invested in developing and demonstrating other biotreatment technologies.

The Army conducted a pilot-scale demonstration of the soil slurry bioreactor (SSBR) at Joliet Army Ammunition Plant (JOAAP). JOAAP was used for studies of chemical and toxicological characteristics. Investigations included analysis of 2, 4, 6-trinitrotoluene (TNT) and its metabolites. Toxicity testing was applied to composted soils in the 1992 Umatilla Army Depot Activity demonstration to prove out the effectiveness of the process. In 1995, the Joliet bioslurry demonstration included the same toxicity tests as used in 1992 with composting. In this study, JOAAP bioslurry test results were compared to compost test results. Tests included the Ames Test and aquatic toxicity to *Ceriodaphnia dubia* test. The Ames Test is performed to evaluate how much the treatment process reduces mutagenicity in *Salmonella* as a measure of human health risk. The *Ceriodaphnia dubia* test is done to assess how much the treatment reduces aquatic toxicity to *Ceriodaphnia dubia*, as a measure of ecological risk.

DESCRIPTION

Biotreatment of explosives-contaminated soils results in intermediate and residual products. Little is known about the products' toxicological properties and therefore, they were tested during this study.

For analytical references, TNT, its major metabolites, and environmental transformation products were procured or synthesized and subjected to a battery of assays. These tests included aquatic toxicity to *Ceriodaphnia dubia*, and mutagenicity to the *Salmonella typhimurium* / mammalian microsome plate incorporation assay (the Ames Test), the Sister Chromatid Exchange (SCE) assay, and the Chinese Hamster Ovary (CHO) assay.

APPLICABILITY

Andrulis Report Requirement:

- 1.3.a Remediation of Explosives in Soil
- 1.3.b On-Site Treatment of Organics Contaminated Soils
- 1.3.c Explosives/Organics Contaminated Sediments
- 1.3.m Soil Bioremediation
- 2.3.d Develop Alternative Technologies to Mitigate Contaminated Soil

ACCOMPLISHMENTS AND RESULTS

Treatment of TNT-contaminated soil in the JOAAP SSBR generally resulted in virtually eliminating TNT and its metabolites under some reactor conditions. The JOAAP SSBR substantially reduced solvent-extractable bacterial mutagenicity in the TNT-contaminated soil, achieving similar results as static pile composts at the Umatilla Army Depot Activity (UMDA) field demonstration, but slightly less than the windrow composting at UMDA. Eliminating aquatic toxicity to *Ceriodaphnia dubia* by TNT in the JOAAP SSBR product soil leachate was accomplished.

Other sources were responsible for residual toxicity. In samples where TNT metabolites were observed in the soil product and its leachates, toxicity was dominated by trace amounts of diamino-metabolites which are toxic to *Ceriodaphnia dubia.* When the SSBR operating conditions reduced TNT metabolites concentrations in product soils and their leachates to undetectable concentrations, the main contributors to aquatic toxicity appeared to be molasses residues (co-substrate which helps microbial metabolism), potassium, and biocarbonate. The following did not appear toxic to soil product: exotoxins, pathogenic bacteria, ammonia, inorganic particles, and dissolved metals. Although potassium and bicarbonate had a negative effect on the predicted toxicity values to *Ceriodaphnia dubia,* these compounds are benign, or beneficial, to the environment.

POINT OF CONTACT

Mark Hampton

PROGRAM PARTNERS

U.S. Army Environmental Center

Umatilla Army Depot Activity, Oregon

Joliet Army Ammunition Plant, Illinois

PUBLICATIONS

Field Demonstration of Slurry Reactor Biotreatment of Explosives-Contaminated Soils; Report No. SFIM-AEC-ET-CR-96178, April 1997.

Windrow Composting Demonstration for Explosives-Contaminated Soils at the Umatilla Depot Activity Hermiston, Oregon; Report No. CETHA-TS-CR-93043, August 1993.

Characterization of Explosives Processing Waste Decomposition Due to Composting; Oak Ridge National Laboratory; TM 12812, September 1994.

Chemical and Toxicological Characterization of Slurry Reactor Biotreatment of Explosives-Contaminated Soils; USAEC Report No. SFIM-AEC-ET-CR-96186; April 1997.

CHARACTERIZATION

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Field Deployable Direct Sampling Ion Trap Mass Spectrometer

The time required for analysis of samples collected during site characterization efforts often delays the decision process. Analysis may take several weeks. As a result, a site may be over-sampled to prevent missing a contaminated area. Developing a capability for field analysis of volatile compounds will allow a more focused assessment and characterization, saving time and reducing sampling costs.

PURPOSE

To create a commercial, affordable, and accurate ion trap mass spectrometer (ITMS) for continuous, in-situ characterization of contaminants in the soil subsurface, surface water, solid waste, as well as liquid and solid phase industrial processes.

BENEFITS

Reduced cost and time to characterize site contamination compared to traditional methods.

TECHNOLOGY USERS

All installations, Formerly Used Defense Sites, DOE, DOIT, EPA-EMSL, and private industry (Teledyne, Monsanto, Phillips Petroleum).

BACKGROUND

Past operations at Army installations involving the manufacturing, handling, and disposal of hazardous materials has resulted in soil and water contamination. Current contamination evaluation methods are costly and time consuming, usually requiring transporting and analyzing samples at an off-site laboratory.

Traditional laboratories use mass spectrometry to analyze water and soil samples with a high degree of certainty. Such laboratory analysis usually takes one to five weeks. A portable, direct sampling ion trap mass spectrometer (DSITMS) can reduce the time, provide accurate analyses, and increase the number of samples analyzed. As a field tool, the system reduces sample collection expenses because it rapidly identifies the extent of site contamination.

DESCRIPTION

The ITMS has been operated in conjunction with the Site Characterization Analysis Penetrometer System (SCAPS) for the characterization of sites contaminated with VOCs.

Teledyne Inc. leads a consortium of private companies and Oak Ridge National Laboratory (ORNL)that secured funding through the Advanced Research Programs Agency for matching funds to commercialize and market the DSITMS. Teledyne has produces seven prototype DSITMS instruments, which are currently being evaluated by consortium members. One prototype is being evaluated as part of the EPA Consortium for Site Characterization Technologies (CSCT) program.

This effort is a three-phase program consisting of a base program, phase 1, and phase 2. The 12-month base program conducted evaluations of the configured ITMS field deployable system. Based on the experience of the users during the field evaluation, a Preliminary Design Review was held to incorporate the recommendations provided by the users into a prototype design. In the current phase 1, the users are conducting field evaluations of the retrofitted instruments produced as a result of the Preliminary Design Review. In phase 2, Teledyne will review the user recommendations from field evaluations and produce field deployable prototype instruments. In addition, a second marketing study will be conducted by Teledyne to further define user requirements, selling price

sensitivities, and potential market size. At the completion of the 36-month effort, the consortium will carry the project through beta testing and production on its own.

APPLICABILITY

Andrulis Report Requirements:

- 1.1.a Develop Improved Field Analytical Techniques
- 2.1.a Volatile Organic Compound (VOC) Emission Control
- 2.1.c Monitoring Air Emissions
- 2.1.g Hazardous Air Pollutant (HAP) Emission Control
- 2.2.h Monitoring at Industrial Water Treatment Plants
- 3.7.f Rapid Field Sample Analysis

ACCOMPLISHMENTS AND RESULTS

The DSITMS has shown sensitivity below 10 ppb for VOC mixtures in laboratory and field studies, in turnaround times of several minutes. The DSITMS has been successfully field tested at various DoD and Department of Energy sites.

The Environmental Protection Agency assigned an SW-846 field method number for the DSITMS VOC analysis methods.

LIMITATIONS

Will be determined during extensive field trials.

RESOURCE SUPPORT

The USAEC, with the lead in this collaborative effort between private industry and the government, provided funding for the Oak Ridge National Laboratory field deployable ITMS development. Teledyne, Inc. manufactures a laboratory bench scale ITMS system. The Advanced Research Projects Agency (ARPA) Technology Reinvestment Program is matching the Teledyne-led consortium funding for commercializing and marketing a field-deployable ITMS.

FOLLOW-ON PROGRAM REQUIREMENTS

The Army will receive six instruments over three years, and needs funding to evaluate the performance and application of the DSITMS to DoD user requirements.

POINT OF CONTACT

George Robitaille

PROGRAM PARTNERS

Advanced Research Projects Agency

Department of Energy

Oak Ridge National Laboratory

Teledyne, Inc.

PUBLICATIONS

Comparison of Direct Sampling Ion Trap Mass Spectrometry to GC/MS for Monitoring VOCs in Groundwater, proceedings of the 4th International Field Screening Symposium, Las Vegas, Nev., February 1995.

Effects of Transfer Line on MS Sampling and Analysis of VOCs in Air, Proceedings from the 43rd ASMS Conference on Mass Spectrometry, Atlanta, GA., May 1995.

Real-Time Continuous Monitoring of VOCs by Direct Sampling Ion Trap Mass Spectrometry, Proceedings of the 3rd International On-Site Analysis Conference, Houston, Texas, January 1995.

Enhanced Sensitivity Real-Time Monitoring of VOCs in Air and Water Using Filtered Noise Field in Conjunction with a Direct Sampling Ion Trap Mass Spectrometer, proceedings from the 42nd ASMS Conference on Mass Spectrometry, Chicago, Ill., May 1994.

Field Transportable Ion Trap Mass Spectrometer, proceedings of the IFPAC ON-SITE Conference, Houston, Texas, January 1994.

"Direct Sampling Ion Trap Spectrometry," Spectroscopy Magazine, April 1993.

Rapid Environmental Organic Analysis by Direct Sampling Glow Discharge Mass Spectrometry and Ion Trap Mass Spectrometry: Summary of Pilot Studies, USATHAMA Report, CETHA-TE-CR 90029.

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SCAPS Probes

The heart of the Site Characterization and Analysis Penetrometer System (SCAPS) are the sensor probes. These provide the capability to identify and quantify contaminants found underground. Sensors exist which can detect and quantify heavy metals, explosives, volatile organic compounds, and Petroleum, Oils and Lubricants (POLs). Many of these sensors have been demonstrated to State and Federal regulators as part of the Validation Program.

PURPOSE

To develop sensor packages which enhance SCAPS capability as an effective DoD tool.

BENEFITS

SCAPS system sensors will reduce costs and speed the decision process regarding site cleanup.

TECHNOLOGY USERS

Army, Navy, and Air Force restoration organizations. Department of Energy. Environmental Protection Agency.

BACKGROUND

The SCAPS system has been proven as an effective tool for rapid site characterization and assessment. Because it pushes the penetrometer into the soil rather than drilling a hole, it is quicker, less expensive, and generates less waste. Sensors to detect and quantify four contaminants (heavy metals, VOCs, POL, and explosives) are currently available.

DESCRIPTION

Heavy Metals

X-Ray Fluorescence - The SCAPS X-Ray Fluorescence sensor detects and quantifies heavy metals in soils. This proven method uses an x-ray source which causes metals to emit unique fluorescence x-rays, which are then analyzed on the surface. The X-Ray Fluorescence sensor can operate above or below the water table.

Laser Induced Breakdown Spectroscopy - The Fiber Optic Laser Induced Breakdown Spectroscopy quantifies metal concentrations by creating a laser-induced plasma. Emissions from the plasma are carried to the surface for spectrographic analysis.

Volatile Organic Compounds

Hydrosparge VOC Sensor Probe - A Hydropunch™ is pushed into the ground creating a temporary monitoring well providing access to groundwater. An in situ sampler (sparger) strips VOCs from the groundwater and returns them to the surface for real-time analysis on-site by an ITMS.

Thermal Desorption VOC Sampler - The SCAPS pushes the sensor to the desired ground depth and a known volume of soil is collected in a sample chamber. Heat is applied and contaminant vapors are purged, transported to the surface, trapped, desorbed, and analyzed in real-time by an onboard ITMS. The sample is expelled, the probe pushed to a new depth, and the process repeated creating the solvent and hydrocarbon map.

Petroleum, Oil and Lubricants

Laser Induced Fluorescence Probe (LIF) -This patented sensor uses ultraviolet

laser energy to induce fluorescence in petroleum, oil, and lubricant contaminants present in subsurface soils. Through a fiber optic cable link, fluorescent energy is returned to the surface for real-time spectral data acquisition and processing.

Explosives

Explosives Sensor - The SCAPS Explosive Sensor detects explosives contamination by heating soil samples to generate nitric oxides which are then detected using an electrochemical sensor inside the probe.

APPLICABILITY

Andrulis Report Requirements:

- 1.1.a Develop Improved Field Analytical Technologies
- 1.1.k Alternative Techniques for Sub-Surface Characterization
- 3.7.f Rapid Field Sample Analysis

ACCOMPLISHMENTS AND RESULTS

- The SCAPS system has been evaluated under the EPA SITE program. Phase 2 technology validation under the EPA-led CSCT was completed in the first quarter of FY96.
- The POL sensor technology has been patented and licensed for commercial production and marketing.
- The POL sensor technology has been demonstrated in Germany and is currently characterizing sites throughout Europe.
- Formalized coordination of SCAPS sensor development efforts among DoD, DOE, and EPA.
- The Army has transitioned three SCAPS trucks to the Corps of Engineers to characterize Army and Air Force sites. The Navy is operating two trucks to characterize Navy sites.
- California has certified the LIF technology. Reciprocity with other states is being pursued through the ITRC.

FOLLOW-ON PROGRAM REQUIREMENTS

Certification with California is currently pending for the VOC sensors, as well as reciprocity with other states through the ITRC.

POINT OF CONTACT

George Robitaille

PROGRAM PARTNERS

U.S. Army

U.S. Navy

U.S. Air Force

U.S. Department of Energy

U.S. Environmental Protection Agency

PUBLICATIONS

Miziolek, A.W., Cespedes, E.R., "Spectroscopic Analysis of Heavy Metal Contamination of the Environment". Optics and Photonics News. Vol. 7, No. 9, p.p.39-41, Sept. 1996.

Adams, J.W., Cespedes, E.R., Cooper, S.S., Davis, W.M., "Development and Testing of Cone Penetrometer Sensor Probe for In-Situ Detection of Explosive Contaminants". Field Screening Methods for Hazardous Waste and Toxic Chemicals. VIP47. Vol. 1. 1995.

CONSERVATION

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Demonstration of Plant Species Selection Software for Land Rehabilitation

Military training and construction activities often damage native vegetation. Revegetation efforts often fail due to improper selection or mixing of seed species and failure to consider a site conditions and intended use. Effective plant species selection will increase land recovery success and speed of land recovery, increasing training opportunities thus improving readiness.

PURPOSE

To demonstrate and validate the VegSpec plant species selection software.

BENEFITS

Planting the appropriate species, in the best way possible, increases the success of land rehabilitation and reduces future maintenance costs.

TECHNOLOGY USERS

Installation Natural Resource Managers

BACKGROUND

Although several thousand woody and herbaceous plant species are commercially available for damaged lands revegetation, experts in the revegetation industry suggest revegetation projects fail 10-35% of the time, depending on the geographic region. Among the most frequently cited reasons for failure are improper species selection and improper species mixtures. Frequently, the species selected are either not adapted to the site conditions or not adapted to the intended land.

DESCRIPTION

VegSpec is an automated system which helps land managers select plants adapted to the conditions or the intended uses of the site for land reclamation projects. By eliminating guesswork in plant species selection, VegSpec enhances the revegetation project's success rate, thereby reducing costs. VegSpec includes land reclamation practices, such as cover crops, critical area planting, windbreaks, filter strips, and planting pastures, ranges and trees. VegSpec requires the user to identify the desired practice, soil series, nearest climate station, and brief site information.

Based on the user input and an "expert" rule set, VegSpec produces a list of plant species adapted to the site. The user may limit the list by identifying specific purposes for the intended practice such as: erosion control, restoring native plant communities, stabilizing slopes, vegetative screening and creation of wildlife habitats. Users may refine the list further by identifying additional objectives and constraints, such as palatability, growth season, and fire tolerance. VegSpec relies on expert rules to compare user and system requirements with a database of over 2,000 plant species. This places the knowledge of national experts in the land managers' hands, saving time and money.

VegSpec lists plant species that meet the selection criteria for user review. After the user makes a selection, VegSpec calculates a seeding rate and evaluates the mixture for potential compatibility problems. VegSpec then guides planting operation design, including planting dates, seed placement, planting method, site preparation, temporary cover, and soil amendments.

Installation demonstration projects for VegSpec have started on abandoned roads and trails at Fort Riley, Kansas, and in areas damaged by intensive military maneuvers at Fort Carson, Colorado. The installations' land managers used VegSpec to generate species list for replanting. The areas revegetated with the species mix suggested by VegSpec will be compared with adjacent areas

revegetated simultaneously with traditional seed mixes. Fort Carson planted in Fall 1995 and Fort Riley planted in Spring 1996 will be monitored through 1997.

USAEC and the U.S. Army Construction Engineering Laboratories (USACERL) will use the demonstration site data to enhance, refine, transfer, and implement the VegSpec technology. A technology transfer package will be created using results from the demonstration cost analyses, implementation guidelines, and design criteria data. The technology transfer package will provide all the information necessary for other sites to implement VegSpec.

In the spring of 1997 VegSpec will be available on the World Wide Web in the Spring 1997. The web version will include a Graphical User Interface.

APPLICABILITY

Andrulis Report Requirements:

- 4.2.i Land Rehabilitation
- 4.3.a Mitigating Army Unique Impacts
- 4.3.c Plant Materials Study
- 4.3.d Erosion Control

ACCOMPLISHMENTS AND RESULTS

A dial-in TelNet version of VegSpec was brought on-line in 1996. Soil and climate data was added to the system.

FOLLOW-ON PROGRAM REQUIREMENTS

USACERL will sample the study sites in September 1997, comparing the VegSpec seed mixtures and the standard seed mixtures on each soil type at each installation. The final report will include all findings and comparisons made of the demonstration and any information that would be pertinent for installation use.

POINT OF CONTACT

Kim Michaels

PROGRAM PARTNERS

U.S. Army Environmental Center

U.S. Army Construction Engineering Research Laboratories

Fort Carson, Colorado

Fort Riley, Kansas

Dust Control Material Performance on Unsurfaced Roadways and Tank Trails

Unsurfaced roadway and tank trail dust present a large and costly environmental and safety problem for Army installation managers. Excessive wear and tear on military vehicles as well as human health and safety factors have caused a great need for an efficient, cost effective technique for dust control. This project provides Army installations with a systematic evaluation of five dust control agents, their application rates, and maintenance requirements. This evaluation process can be used on other agents as well, setting the stage for an Army wide dust control program.

PURPOSE

To evaluate the effectiveness, cost, and maintenance requirements associated with several dust control agents when used on road segments and tank trails. This information will provide guidance to Army environmental and safety managers in developing an aggressive and cost effective dust control program.

BENEFITS

Effective dust control will reduce fugitive dust increase safety and air quality thus decreasing the chance for accidents and excessive vehicle repair, creating overall a healthier training environment.

TECHNOLOGY USERS

Training Area and Installation Natural Resource Managers

BACKGROUND

Fugitive dust generated from wheeled and tracked vehicle training exercises create many different kinds of problems. Most notable of these problems are associated with safety, air quality, increased military vehicle maintenance requirements, and tactical considerations. Dust clouds generated from road segments and tank trails impair the visibility of military vehicle operators, increasing the likelihood of accidents and injury. Excessive dust from tank trails act as a respiratory irritant to military vehicle operators and is considered a safety and air quality hazard when it drifts into nearby housing and administrative areas or onto adjacent highways and streets. Excessive wear and tear on military vehicles result from the intrusion of dust into engine and turbine compartments, air filtering systems, and other sensitive mechanical and electrical components. Finally, dust generated from wheeled and tracked vehicle movement provide an unmistakable signature to enemy forces in a tactical scenario. An aggressive dust control program has the potential to minimize these problems, but requires a systematic evaluation of dust control agents, application rates, and maintenance requirements in order to be labor and cost effective.

DESCRIPTION

Recently, many materials which are environmentally safe and satisfy cost, efficacy, durability, and maintenance requirements, have entered the commercial market. These products have proven successful on the commercial market and show promise on unimproved roadways where rough terrain makes traditional road maintenance difficult and costly.

The products are not petroleum based and in some instances are by-products of agricultural crops.

USAEC teamed with USACERL have evaluated and compared several types of dust control agents for their long-term effectiveness, cost, and maintenance requirements. These products are: Calcium-ammonium lignosulfonate (Lignin LS-50), Polyvinyl acrylic polymer emulsions (TopSeal and SoilSement), SoyBean

by-products (SoySeal6), and Calcium Chloride (Dust Fyghter). The products demonstrated are all applied with liquid distributors. The equipment is simple to operate and readily available at most Army installations.

The results allow Army installations to provide realistic training while maximizing environmental compliance and safety. Dust control agents were demonstrated at Fort Hood, Texas, and Fort Sill, Oklahoma, comparing dust control products in large-scale field test under carefully controlled and replicated conditions.

A dust control program will help installations minimize operational and environmental problems. An aggressive dust control program requires a systematic evaluation of dust control agents, application rates, and maintenance requirements.

Applicability

Andrulis Report Requirements:

- 4.3.d Erosion Control
- 4.2.i Land Rehabilitation
- 4.3.b Safety Issues
- 4.2.1 Develop and Perform Maintenance on Land
- 4.5.b Reduce Maintenance
- 4.5.e Wind Blown Particles, the Next Crisis in the West

Accomplishments and Results

This project was discussed in the Environmental Update and has generated widespread interest. The technical report is currently being distributed.

This project was briefed at the FY96 LRAM Conference. The response at the conference was positive.

The project results will be briefed at the ADPA 23rd Environmental Symposium and Exhibition in April, 1997.

Point of Contact

Kim Michaels

Program Partners

U.S. Army Environmental Center

U.S. Army Construction Engineering Research Laboratories

Fort Hood, Texas

Fort Sill, Oklahoma

Publications

USAEC/USACERL Technical Report: Dust Control Material Performance on Unsurfaced Roadways and Tank Trails, September, 1996.

Operation and Maintenance Manual for Small Arms Range Management

Maintenance of small arms ranges must be conducted in a manner which protects the environment and complies with environmental regulations. Procedures do not currently exist for range managers to conduct environmentally proactive maintenance activities. An Operation and Maintenance Manual will provide a reference and planning tool for training range management. Application of the techniques in such a manual will minimize downtime for ranges and maximize training opportunities for soldiers.

PURPOSE

To develop an Operation and Maintenance manual for small arms range management to reduce the impact of Environmental Regulations on training.

BENEFITS

At the completion of the effort, an Operation & Maintenance manual will be available for distribution to and use by Range Managers.

TECHNOLOGY USERS

Range Managers.

BACKGROUND

Numerous Department of Defense (DoD) installations contain small arms ranges that may pose a risk to environmental quality in the form of heavy metal migration and accelerated erosion rates. A Worldwide Environmental Range Strategy has been devised through the combined efforts of Army Training Support Center (ATSC) and USAEC in an attempt to minimize environmental impacts from range activities while reducing the impacts on the training mission. A number of new technologies are currently being developed and implemented for the reduction of environmental impacts of small arms ranges and the associated risks.

DESCRIPTION

Army ranges are currently sited in accordance with the procedures outlined in Chapter 4 of Training Circular (TC) 25-8, Training Ranges. Certain site characteristics (physical, geochemical, hydrogeological, climatological, etc.) may increase the risk of heavy metal migration into groundwater, surface water, and vegetation. In addition, the build-up of rounds and fragments result in accelerated erosion rates. Such a build-up could potentially contribute to migration of heavy metals into soil, groundwater, and surface water resources. Preventative measures are being sought to maintain compliance with Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation Liability Act (CERCLA), and the Clean Water Act (CWA), and to reduce the need for costly cleanup operations in the future.

All relevant information regarding the operation and maintenance of small arms ranges will be compiled and organized for incorporation into the manual. The information will assist in the ranges' operation and maintenance in a manner that reduces spreading heavy metals, that is in compliance with all laws and regulations, and that demonstrates a proactive approach to environmental stewardship. Additional information will be sought from the U.S. Army Waterways Experiment Station (USAWES), the U.S. Army Engineering and Support Center, Huntsville, the ATSC Range Assistance Team and Training Land Management Team, and MACOM/installation range managers. The Manual will be presented in a comprehensive, non-technical format suitable for distribution to and application by range control personnel. The manual will also include standard procedures and schedules for "harvesting" lead as well as avenues for recycling rounds and fragments from berms. Successful standard operating procedures

combined with technologies currently being developed under DoD will provide range managers with the necessary tools to maintain compliance without impact to readiness.

Data collection and a draft manual outline have been completed.

APPLICABILITY

Andrulis Report Requirements:

- 1.2.e Inorganics in Groundwater
- 1.4.c Heavy Metal
- 4.2.1 Develop and Perform Maintenance on Lands
- 4.3.d Erosion Control

ACCOMPLISHMENTS AND RESULTS

LB&M has completed the data collection phase and prepared a draft outline of the manual. A meeting will be held at USAEC during the second week in March to review the draft O&M Manual and provide input to the final document. The Operation and Maintenance Manual will be complete and ready for Army-wide distribution in May 1997.

RESOURCE SUPPORT

VENC

FOLLOW-ON PROGRAM REQUIREMENTS

ATSC may select USAEC to modify and incorporate the O&M Manual into Chapter 4 of TC 25-8, Training Ranges. Updates to the Manual will be available via the World Wide Web.

POINT OF CONTACT

Lisa Miller

PROGRAM PARTNERS

U.S. Army Environmental Center

Army Training Support Center

U.S. Army Corps of Engineers Waterways Experiment Station

U.S. Army Engineering and Support Center, Huntsville

MACOM/Installation Range Managers

ProbeCorder: Pen-based Computing for Field Recovery of Subsurface Testing

Army installations are faced with increased requirements for documenting archaeological resource inventory and assessment, as well as geomorphologic and other soil studies. Cultural resource managers need tools to free staff to focus on other cultural and environmental challenges. The ProbeCorder is a pen-based software tool designed to maximize subsurface testing efficiency by automating the routine collection, integration, and storage of probe data in the field.

Purpose

To provide installation cultural resources managers with proficient and efficient data collection abilities. The system automates the recording of subsurface testing data derived from archaeological resource inventory and assessment, as well as geomorphologic and other soil-related studies.

Benefits

The system is geared for installation archaeologists and cultural resource managers, however, there is great potential for this system to be used in other areas that have a need for automated data collection.

Technology Users

Installation Environmental Managers

Background

Archaeological site discovery is an expensive aspect of historic property inventory faced by the installation in areas where these sites are either obscured by dense vegetation or where they are buried by more recent sedimentation episodes. Both situations require subsurface testing for reliable site discovery and geomorphologic assessment. Subsurface testing is also routinely used as a method of assessing the stratigraphic integrity of archaeological sites, which is an important criterion for determining significance and potential eligibility to the National Register. These procedures are extremely costly and labor-intensive since they involve repeated, closely spaced probing by means of shovel-testing, post-holing, bucket augering, deep coring, or backhoe trenching. Procedures for field data collection and post-field data integration and processing should be as efficient as possible to reduce high costs.

The system's cost effectiveness is achieved by eliminating the tedious and error-prone database entry and digitizing required by using multiple paper-field forms and sketch maps.

The National Historic Preservation Act (NHPA) requires that all Federal land managing agencies, including DoD, conduct baseline inventories of historic properties and take into account the effect of their undertakings on those properties which are on, or are eligible for, the National Register of Historic Places.

Description

The project will involve:

- Evaluations of commercially available hardware and software comparable to those on which ProbeCorder was developed. The results of this evaluation will be documented and incorporated into the ProbeCorder user's manual to allow installation resource managers to make informed decisions regarding which equipment will best suit their needs.
- Implementation of end-user customization capability for the ProbeCorder to allow pick lists to be modified through Graphical User Interface. Completion of a full range of on-line HELP screens to guide the user through the entire

ProbeCorder data recording and output process.

- The USAEC will produce and transfer the ProbeCorder software package to installations/agencies. The ProbeCorder will be demonstrated at three Army installations: Fort Leonard Wood, Missouri; Fort Riley, Kansas, Fort Bliss, Texas and Camp Dodge, Iowa. The results of the demonstration will be implemented into the system after coordinating results with USAEC.

APPLICABILITY

Andrulis Report Requirements:

- 4.1.a Identification and Protection of Sites
- 4.1.b Complete Historic Resource Inventory
- 4.1.g Site Significance Assessment.

POINT OF CONTACT

Kim Michaels

PROGRAM PARTNERS

U.S. Army Environmental Center

U.S. Army Construction Engineering Research Laboratories

Fort Bliss, Texas

Fort Leonard Wood, Missouri

Fort Riley, Kansas

Camp Dodge, Iowa

Tactical Concealment Areas (TCA) Planning and Design Guidance Document

Installation trainers and environmental resource managers need tools to help them combat the problems of training site degradation and rehabilitation. Tactical Concealment Areas (TCA) provide such a tool by enhancing wildlife habitat, protecting environmental resources, and providing soldier safety. USAEC and the USACERL have developed a planning and design tool to help trainers and land managers enhance installation training resources using suitable development techniques.

PURPOSE

To demonstrate the applicability, usefulness, and viability of an installation-based tactical concealment guidance document. This document will give the installation the opportunity to create and integrate tactical concealment into total training area design. The document will also provide sufficient guidance, allowing the installation to complete work in-house rather than by contract.

BENEFITS

TCA presents an approach to training land design that realizes a systematic integration of training and environmental requirements to enhance and expand an installation's training resources. The benefits of this technology will include more realistic training areas, protection of natural and cultural resources, and enhancement of environmental stability.

TECHNOLOGY USERS

Army trainers and installation natural and cultural resources managers.

BACKGROUND

The development and use of well designed tactical concealment enhances training realism and effectiveness by providing cover/concealment in a tactical training environment. The added benefit of isolating potentially hazardous areas and protecting sensitive areas from training activities suggests that tactical concealment needs to be carefully designed and integrated into the total training area design and the environment to optimize effectiveness and overall environmental stability. The first tactical concealment design done in the United States was implemented at Fort Riley, Kansas. The design constructed was a cluster of horse-shoe shaped islands. Subsequent tactical concealment areas implemented at other installations followed the Fort Riley design with slight modifications. Recent observations of the designs' military use indicate design flaws. Current efforts are being taken to evaluate these flaws and to eliminate them in future designs.

DESCRIPTION

TCA is a holistic approach which considers an installation's training needs, existing resource conditions and environmental constraints in planning and designing realistic training areas. The result is greater safety, less equipment damage, fewer environmental impacts, and expanded and/or enhanced training realism. The tool takes the form of a guidance document which details how to integrate both training and environmental considerations into the planning process and how to effectively implement the design. The guidance document will give installations the opportunity to complete work in-house rather than contracting out the work, saving money and affording the installations more control over their projects.

The TCA guidance document will be field tested at three Army demonstration sites; Camp Bullis, Texas; Illinois National Guard; and Fort Hood, Texas. The demonstrations will prove guidance document installation utility and applicability.

APPLICABILITY

Andrulis Report Requirements:

- 4.2.a Land Capability/Characterization
- 4.3.a Mitigating Army Unique Impacts
- 4.2.i Land Rehabilitation.

Integrated Training Area Management Requirements:

- 7 Integrate Training and Environmental Requirements
- 9 Maintain and Repair Land.

ACCOMPLISHMENTS AND RESULTS

This project was well received when briefed at the FY 96 Integrated Training Area Management (ITAM) Conference.

POINT OF CONTACT

Kim Michaels

PROGRAM PARTNERS

U.S. Army Environmental Center

U.S. Army Construction Engineering Research Laboratories

Fort Hood, Texas

Illinois National Guard

Camp Bullis, Texas

PUBLICATIONS

The guidance document is currently in its draft form. The final document is to be published Fall of 1998.

OTHER ENVIRONMENTAL AREAS

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Aluminum Ion Vapor Deposition

Metal coating processes at Army depots may produce hazardous wastes and threaten workers' safety. Aluminum provides an improved coating, greater process flexibility, and enhanced environmental operations.

PURPOSE

To support technology transfer and implementation of Aluminum Ion Vapor Deposition (AIVD) at Tobyhanna Army Depot (TOAD). Since the beginning of the Army Materiel Command's (AMC) Hzardous Waste Minimization (HAZMIN) program, the U.S. Army Environmental Center (USAEC) has supported HAZMIN initiatives at all AMC industrial operations. Specific initiatives relating to Initial Operating Capability facilities have included demonstrating and implementing AIVD at Anniston Army Depot, Alabama. The objective of the current task is to provide Initial Operating Capability with support for technology transfer and implementation of AIVD at Tobyhanna Army Depot (TOAD), Pennsylvania.

BENEFITS

AIVD offers several advantages over cadmium electroplating:

- No hazardous wastes are generated
- Avoids employee exposure to hazardous materials
- Reduces loading to wastewater treatment plants
- Environmental permits are not required
- Outperforms cadmium coatings in preventing corrosion in acidic environments
- Coatings can be used in high temperature service (925 ^{0}F versus 450 ^{0}F for cadmium)
- Permits thicker coatings and provides better uniformity of coating on edges and corners than solution electroplating

TECHNOLOGY USERS

Army Depots

BACKGROUND

Since the beginning of the AMC's HAZMIN program, USAEC has supported HAZMIN initiatives at all AMC industrial operations. Specific initiatives relating to Initial Operating Capability facilities have included demonstrating and implementing AIVD at Anniston Army Depot, Alabama.

Industrial fabrication and maintenance activities conducted at Army depots typically include metal plating operations. For many years, metal parts have been electroplated with cadmium. Cadmium surface coatings provide protection from corrosion. However, cadmium is a toxic metal and electroplating generates significant quantities of wastes such as spent plating baths, sludge, and rinse waters. Cadmium wastes are regulated by the EPA as hazardous waste RCRA. Treatment of spent solutions and rinse waters in on-site industrial wastewater treatment plants also generates cadmium contaminated sludge that is regulated as hazardous waste. Further, cadmium exposures in the workplace are regulated by OSHA. Cadmium contamination in fumes, dust, and mists, which commonly occur in industrial operations, is tightly regulated.

The inherent difficulties in safely handling toxic materials in the workplace and the increasing costs associated with management and disposal of hazardous wastes have become incentives for minimizing hazardous wastes generation and for pollution prevention at the source. Aluminum surface coatings can be substituted

for cadmium in many applications. AIVD is a clean technology that can be used to apply aluminum coatings to metal and other substrates, including plastics and composites.

DESCRIPTION

Cadmium electroplating, a significant hazardous waste source at Army industrial operations, is applied to many metal parts to protect surfaces. AIVD, a surface-plating technology, applies aluminum coating. However, it does not generate hazardous waste. It also reduces employee exposures to cadmium and provides corrosion protection. Letterkenny Army Depot (LEAD), Pennsylvania., received HAZMIN technical assistance for treatment of methylene chloride contamination in paint-stripping rinse waters.

Activities have focused on technical support and technology transfer at TOAD to support the evaluation and acquisition of AIVD technology. Work has included preparing economic analyses and equipment bid specifications and providing technology transfer materials.

APPLICABILITY

Andrulis Report Requirement:

- 2.3.e Alternatives for Hazardous Materials used in Production Process

RCRA

OSHA

ACCOMPLISHMENTS AND RESULTS

- Completed economic analysis and bid specification for AIVD at Tobyhanna.
- An Economic Analysis for an AIVD system, a Work Order for AIVD system installation, and a collection of information on AIVD technology and coatings.
- Visited Anniston and Corpus Christi Army Depots to observe existing AIVD systems and discuss acquisition, equipment options and operation, and lessons learned with current operators.
- Conducted a technology search for methods of treating methylene chloride contaminated wastewater was.

LIMITATIONS

The AIVD coating is not a universal substitute for cadmium. Replacement of current plating technology must be evaluated case-by-case (often for individual parts). Part specifications that require cadmium coatings cannot be substituted for AIVD coatings without approval of the part's owner or manager.

FOLLOW-ON PROGRAM REQUIREMENTS

- Implementation support complete at TOAD.
- Present project results at the Tri-Service Environmental Technology Workshop in May 1995.

POINT OF CONTACT

Gene Fabian

PROGRAM PARTNERS

U.S. Army Environmental Center

Anniston Army Depot, Alabama

Corpus Christi Army Depot, Texas

Letterkenny Army Depot, Pennsylvania

Tobyhanna Army Depot, Pennsylvania

PUBLICATIONS

Final Report, Technical Support for Reduction of Methylene Chloride Contamination in Paint-Stripping Rinse Waters at LEAD, February 1996. Report Number SFIM-AEC-ET-CR-96004.

Final Report, Technical Support for Implementation of Aluminum Ion Vapor Deposition at Tobyhanna Army Depot, February 1996, Report Number SFIM-AEC-ET-CR-96006.

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Antifreeze Recycling Demonstration

While antifreeze is an essential fluid used in Army and DoD vehicles, it also presents a management challenge due to its toxicity and widespread use. Recycling antifreeze will protect the environment and conserve operations and maintenance resources that would otherwise be spent on disposal of old and purchasing new antifreeze.

PURPOSE

To gain experience in installing, training, and operating DoD-approved antifreeze recycling units at user sites.

BENEFITS

Recycling antifreeze will reduce the disposal costs for ethylene glycol, which is on the top 10 chemicals in the Toxic Release Inventory report. Recycling antifreeze also is cost effective and has a payback period of approximately two years.

TECHNOLOGY USERS

Installation staff, maintenance personnel, and environmental coordinators.

BACKGROUND

In 1993, the Mobility Technology Center - Belvoir approved two commercially available antifreeze recycling systems that met the specifications for MIL-A-46153. These systems include the B.G. Products, Inc., *Cool'r Clean'r Coolant Purification System* and the Finish Thompson, Inc., *BE Series (BE15 or BE-55) Coolant Reclaimer Systems.* These systems were approved in the laboratory, but have never been tested in the field for performance and usability data. The purpose of this project is to develop user friendly manuals for both recycling systems and transfer that information into the field for Army use.

DESCRIPTION

Recycling used antifreeze is an approved pollution prevention technology. The Tank and Automotive Command Research, Development and Engineering Center at Fort Belvoir, Virginia., has approved two antifreeze recycling units for Army use.

Millions of gallons of antifreeze are used by the military every year. Military specifications require changing antifreeze at specific intervals. Therefore, millions of gallons of waste antifreeze are generated each year. This project demonstrates commercial antifreeze recycling technology at Army motorpools. The results will be user friendly user manuals and acceptance of recycled antifreeze. Thereby, lowering vehicle maintenance costs.

This project has installed the approved units at four operating sites, under U.S. Army Forces Command (FORSCOM), U.S. Army Training and Doctrine Command (TRADOC), U.S. Army Reserve Command (USARC), and the National Guard Bureau (NGB). The purpose is to gain experience installing, starting up and operating these units, and to publish the lessons learned in this project for Army-wide use. Researchers will develop training and maintenance guidance for Army-specific use of this equipment.

Recycle units are part of a one-year demonstration to judge the recyclers' effectiveness to process used military MIL-A-46153 antifreeze. Test vehicles will have the recycled antifreeze tested for pH, reserve alkalinity, appearance, freezing point, and metal concentrations at three-month intervals for one year.

Once the demonstration is complete, user manuals will be updated and sent to Army users. These user manuals will follow a step-by-step approach regarding

antifreeze recycling so soldiers in the field can operate the unit.

APPLICABILITY

Andrulis Report Requirement:

3.7.d - Substitution and Recycling of Antifreeze (pollution prevention)

ACCOMPLISHMENTS AND RESULTS

Four units have been purchased and installed. The field demonstrations are underway. Installed the BG Products Cool'r Clean'r Recycling System at the 88th U.S. Army Regional Support Center, Indiana, and Fort Bliss, Texas.

The BE-55C Coolant Recycler from Finish-Thompson, Inc., is installed at the Department of Logistics Maintenance Facility at Fort Drum, New York and at Camp Dodge, Iowa.

LIMITATIONS

No known limitations exist for the proper use of this equipment.

RESOURCE SUPPORT

VENC

POINT OF CONTACT

Peter Stemniski

PROGRAM PARTNERS

U.S. Army Environmental Center

Mobility Technology Center - Belvoir

Fort Bliss, Texas

Camp Dodge, Iowa

88th Regional Support Command, Indiana

Fort Drum, New York

BG Products, Inc.

Finish Thompson, Inc.

PUBLICATIONS

Antifreeze Recycling Users Guide, Belvoir Research, Development and Engineering Center, Letter Report 94-2. (available from POC).

Extraction and Chromatigraphic Development of Selected Organophosphorous Compounds from Soil and Aqueous Media

The success of our armed forces and safety of our soldiers depends on our ability to deter and detect the use or production of nerve agents. The ability to safely cleanup former production, testing, or storage sites improves our ability to deter production and use. Improved knowledge of the environmental fate of alkyl methylphosphonates through ion chromatography enhances our ability to detect such usage.

PURPOSE

To determine if non-chemical surety materials (CSM) could contribute to alkyl methylphosphonate contamination in environmental media and to develop an environmental fate model for alkyl methylphosphonates in soil systems.

BENEFITS

Increased knowledge of Alkyl Methylphosphonates (Nerve Agents) degradation products thereby reducing cleanup cost and down time for training.

TECHNOLOGY USERS

All soldiers and range personnel.

BACKGROUND

Organophosphonate nerve agents are relatively easy to manufacture, and the possibilities for their use were very evident during the Persian Gulf War. The need to verify their use or production is a major concern in chemical weapons disarmament negotiations. Additionally, the peacetime efforts to reduce chemical agent stockpiles and to clean-up sites, sites where they were tested, stored, or produced, has led to the need for improved information of the environmental fate of these compounds.

DESCRIPTION

Four alkyl methylphosphonates: pinacolyl methylphosphonate (PMPA), isopropyl methylphosphonate (IMPA), ethylmethylphosphonate (EMPA), and methylphosphonate (MPA) have long been used as surrogate compounds to detect phosphonofluoridate nerve agents in environmental media. This project has developed an ion chromatographic method that successfully separates all four alkyl methylphosphonates in a single run on a solvent-compatible ion-exchange column.

While ion exchange is the principal retention mechanism, reversed-phase selectivity provides the required separation. This method requires minimal sample preparation and was applied to surface and ground waters using both spiked and authentic samples.

In general, the primary mode of degradation is by hydrolysis to the corresponding alkyl methylphosphonate, followed, in some cases, by a second hydrolysis to methlphosphonic acid. The hydrolysis reactions are easily catalyzed by a variety of chemicals, resulting in greatly accelerated degradation in the heterogeneous medium of soils.

APPLICABILITY

Andrulis Report Requirements:

- 1.1.a Develop Improved Field Analytical Techniques
- 1.1.i Standard Analytical Methods for Army-Unique Compounds
- 1.2.b Organics in Groundwater
- 1.3.h Determine Natural Attenuation Rates of Army-Unique Compounds

- 1.5.a Chemical Warfare Material Fate/Transport Prediction

ACCOMPLISHMENTS AND RESULTS

A working, empirical, soil fate model for methylphosphonates has been developed. The model indicates that soils with significant hydrolysis rates, the dialkyl methylphosphonates are more important contributors to long term soil contamination than the nerve agents. However, if degradation rates are near zero, as in the two western soils, alkyl methylphosphonates, but not MPA, arising from agent degradation may be environmentally significant.

LIMITATIONS

The existing fate model's predictive power will be greatly increased by extending the approach to homogeneous solid phase systems.

FOLLOW-ON PROGRAM REQUIREMENTS

Technology Transfer of this information.

POINT OF CONTACT

Tony Perry

PROGRAM PARTNERS

U.S. Army Environmental Center

University of Delaware, Department of Civil and Environmental Engineering

PUBLICATIONS

Final Report available.

Remediation Technologies Screening Matrix and Reference Guide

> In the past, numerous agencies, divisions, and branches of the government produced documents as tools for their environmental project managers to make intelligent decisions on technologies to use for site clean-up. Lack of coordination led to duplication of effort by the various agencies, divisions and branches. The Federal Remediation Technologies Roundtable developed a guide which serves as a neutral platform to evaluate technology decisions.

PURPOSE

To update the Federal Remediation Technologies Roundtable (FRTR) Remediation Technologies Screening Matrix and Reference Guide while producing a real-time, easy-to-update document.

BENEFITS

The value-added of the product is the electronic document that will serve as a neutral platform for Environmental Remediation technology. The Screening Matrix will serve as an unbiased medium from which those interested in remediation technologies can research initial information sources. The initial time and effort investments to update and cross-reference the document into a "one-stop-shopping" format will result in time and effort savings for each user

This project is expected to help foster/demonstrate cooperation among DoD and all Federal agencies and provide an improved technology transfer product to both the environmental technology user community and the research and technology development community.

TECHNOLOGY USERS

Army, Public Agencies, and Private Organizations

BACKGROUND

In the past, numerous agencies, divisions, and branches of the government produced documents as tools for their environmental project managers to make intelligent decisions on technologies to use for site clean-up. The Federal Remediation Technologies Roundtable sponsored the production of the FRTR Remediation Technologies Screening Matrix and Reference Guide, 2nd Edition, to eliminate the duplication of efforts of the member agencies. It has come apparent that knowledge of environmental cleanup technologies has increased rapidly making the 2nd Edition dated. There is a need to update and improve the Screening Matrix.

DESCRIPTION

The document will be formatted to be primarily electronic in nature allowing for quick and easy improvements and updates. The update will also commit the Roundtable Members to work together, leveraging funds and resources, and preventing duplication of effort.

Technologies included in the update were selected by the committee representatives. Each agency had the option of taking the lead for each technology. They also have the option to serve as a review entity for each technology.

Once the technology description is written, it will be reviewed by those interested. The technology description will be placed in HTML formatting, integrated with all necessary hyperlinking, and placed on the server for universal use.

The current WWW version of the Screening Matrix and Reference Guide is located on the Federal Remediation Technology Roundtable homepage. The

updated version will replace this document. There will be efforts to continually update and ensure the document's integrity.

Accomplishments and Results

The major success to date has been the strides made during the 10 December 1996 meeting held at LGS Turner & Associates which included representatives from 90% of the agencies and the others providing input via telephone. The meeting allowed the committee members to meet and establish personal relationships which will be necessary to coordinate the update effort.

Currently, the Air Force, Naval Facilities Engineering Service Center, U.S. Army Corps of Engineer Missouri River Division, EPA Innovative Technology Office, and EPA Risk Reduction Engineering Laboratory are exploring ways to either send funding for support contractors or delegating time from their agency's support contractor to the update effort.

Limitations

As a result of numerous conference calls and meetings, an analysis of the document by the member agencies has revealed the following limitations:

- it reached the practical limit in terms of how much can be reported and distributed economically in a paper format (600 pages),
- it contains outdated reference information and no longer contains a complete up-to-date set of basic cleanup technologies,
- it focuses primarily on mature technologies at the exclusion of newer developing technologies, and
- although it was also produced in an electronic format, more advanced and desirable reporting techniques currently exist using the capabilities of the World Wide Web (WWW).

Follow-On Program Requirements

Completed

- Funded efforts required to upgrade the previous Windows based electronic version of the Remediation Screening Matrix and Reference Guide for application on the WWW.
- Established relationships and level of interest and reconvened a committee of representatives from among FRTR member agencies.
- Attended the fall FRTR meeting and presented consensus from among member agencies and sought additional funding support.
- Presented project proposal, solicited agency funding contributions.
- Received funding commitment from member federal agencies.

Future

- Discuss/prioritize/decide future update efforts based on committed funding amounts.
- Initiate additional update efforts based on agreed future plans, and existing USAEC and FRTR member agency in-house and USAEC contract support capabilities.
- Receive additional agency funding contributions.
- Modify existing USAEC contract statement of work and award additional funds for tasks as identified above by FRTR member agencies.
- Coordinate/execute update efforts.
- Complete update efforts.

POINT OF CONTACT Dennis Teefy / Edward Engbert

PROGRAM PARTNERS U.S. Army Environmental Center

PUBLICATIONS NTIS has available the FRTR Screening Matrix and Reference Guide, Document No. PB95-104782 (paper copy) or No. PB95-501-771 (WordPerfect DOS and Envoy Windows versions). Also available on the World Wide Web at http://WWW.FRTR.GOV

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Saltsburg CNS Tear Gas Landfill Project

Several private facilities exist in the United States which were used to provide military unique compounds to the Department of Defense. Past manufacturing and disposal practices have resulted in many states being contaminated. This project will assist the site owner to identify innovative environmental remediation technologies that will address contamination resulting from the landfilling of 300-1700 55 gallon drums of CNS Tear Gas fluid

PURPOSE

To assist the site owner of the Area 15A Federal Laboratories CNS Tear Gas Landfill, TransTechnology Corporation, and the Pennsylvania Department of Environmental Protection (PaDEP) identify viable remediation technology alternatives for the site. In addition, to perform a fate, transport, and effects study to determine the environmental end-points for the contaminants of concern.

BENEFITS

The Army and the TVA, will develop knowledge and experience relating to CNS tear gas fluid (i.e. chloroacetophenone, chloroform and chloropicrin) components in a landfill environment. Analytical methods will be developed and refined for determining the existence of these compounds in environmental samples. A fate, transport, and effects study for tear gas will be performed.

TECHNOLOGY USERS

Primary: TransTechnology Inc. (Site Owner)

Secondary: PaDEP, Department of the Army

BACKGROUND

The Saltsburg Federal Laboratory facility manufactured tear gas and various other military unique products for the United States Department of War. These materials were disposed by the past site owner according to commonly accepted practices of the time and before specific waste disposal regulations were implemented. In the late 1940's, an 300 to 1,700 (estimated) barrels of tear gas were buried in Area 15A.

This project is being performed by ETD of Department of the Army and Congressional direction.

DESCRIPTION

This project is to use innovative site characterization technologies in conjunction with scientific study to demonstrate the efficacy of engineering and scientific approaches for delineating the levels and extent of contamination at Area 15A.

The Army's strategy for the Saltsburg Tear Gas Landfill Project entails a Three Pronged Approach, with each element of the Army's strategy building upon knowledge, findings, and experience realized from the other prongs. The Army's Three Prong Approach includes:

- Demonstrate innovative engineering and scientific approaches for delineating the current extent and level of contamination resulting from the 500-1500 deteriorating 55-gallon drums of CNS tear gas fluid in landfills. This will be conducted in a manner that will fill in gaps in existing site characterization documentation provided by TransTechnology.
- Conduct a fate, transport, and effects study, analysis, and modeling for CNS tear gas fluid and its degradation products. The information obtained from this study will be a vital link in determining the human health and risk effects,

and potential for remediation through natural attenuation.

- Identify remediation options and evaluate the technical merits of those options for addressing contamination types that exist at Area 15A.

The Tri-Service Site Characterization Analysis Penetrometer System (SCAPS) will assist in the first and second aspects of the approach using the VOC sensors and the Ion Trap Mass Spectrometer (ITMS).

Applicability

Under the framework of the Andrulis Report, this project may potentially meet the following requirement statements:

- 1.2.b Organics in Groundwater
- 1.2.f Alternatives to Pump and Treat
- 1.5.a Chemical Warfare Material Fate/Transport Predictions
- 1.1.i Standard Analytical Methods for Army Unique Compounds
- 1.1.k Alternative Techniques for Sub-Surface Characterization
- 1.1.f Non-Invasive Field Techniques
- 1.3.h Determine Natural Attenuation Rates of Army-Unique Compounds

Accomplishments and Results

- Briefed TransTechnology Corporation, Federal Laboratories, PaDEP and Congressman's Murtha's Office
- Provided support to the Department of the Army, Office of the General Counsel (HQDA) to assist with negotiations and acceptance of the Army's proposal for the site
- Conducted Saltsburg Project site visit and kick-off meeting at PaDEP with TransTech Federal Laboratories, PaDEP, Congressman Murtha's Office, USAEC and TVA.

Resource Support

FY 95 RDT&E funding. Congressional line item; Environmental Quality Technology, Saltsburg remediation Technology.

Follow-On Program Requirements

- Conduct post award conference and site visit
- Obtain relevant historical records and information regarding the environmental condition and site characterization of Area 15A
- Perform a site walkover of the tear gas landfill and gather information
- Sample groundwater from existing production wells on site
- Analyze and compare results with most recent sample analysis data
- Plan and coordinate site characterization technologies demonstration
- Investigate Potential Innovative Remedial Options for Area 15A

Point of Contact

A.J. Walker

Program Partners

U.S. Army Environmental Center

TransTechnolgy Inc.

Pennsylvania Department of Environmental Protection

Tennessee Valley Authority

PUBLICATIONS

Environmental Site Assessment, Federal Laboratories, Inc., Saltsburg Pennsylvania, Earth Sciences Consultants Inc., July 1985.

Removal Site Evaluation/Feasibility Study, Federal Laboratories Facility, Saltsburg Pennsylvania, Earth Sciences, Inc., October 1992.

Summary of Site Characterization Studies, Federal Laboratories Facility, Saltsburg Pennsylvania, Earth Sciences Inc., October 1992.

Draft Risk Assessment for Remedial Alternatives, Federal Laboratories Facility, Saltsburg, Pennsylvania, ICF Kaiser Engineers, October 28, 1992.

1996 Budget Proposal United States Department of Defense, Environmental Cleanup of Federal Laboratories Plant No. 3 and The Demonstration of Innovative Remediation Technology, Saltsburg, Pennsylvania, TransTechnology Corporation, December 29, 1994.

Supplemental Investigations Report, Federal Laboratories Facility, Saltsburg Pennsylvania, Conestoga-Rovers and Associates, September 20, 1995.

Draft, Test Plan for Phase II of the Tear Gas Fate and Effects Study, Tennessee Valley Authority, January 1997.

Draft, Sample Collection Plan for Soil and Groundwater Near Area 15A at the Federal Laboratories Facility Saltsburg, Pennsylvania, Tennessee Valley Authority, January 1997.

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U.S. Army Environmental Technology User Requirements

Like all DoD members, the Army has a list of environmental requirements that are to be met in order to comply with environmental regulators. To expedite the process of meeting these requirements, the U.S. Army Environmental Center is developing a list of commercially available technologies that are ready to be used for environmental cleanup.

PURPOSE

To aid the Army in better identifying opportunities to demonstrate and use faster and more cost-effective systems that employ new technologies.

BENEFITS

Aid the Army in better identifying opportunities to develop, demonstrate and use improved environmental systems that employ new technologies.

TECHNOLOGY USERS

All DoD installations that use technologies to satisfy their environmental requirements.

BACKGROUND

The time and cost required to test, evaluate, and implement readily available commercial technologies are potentially far less than those associated with the traditional research and development process. In some cases, using a commercially available technology may require changes to military specifications or user's manuals. The cost-benefit analyses emphasis in the USAEC study is intended to help the military capitalize on its environmental technology research and development efforts while funding is being decreased. Representatives of the organizations with technology requirements will be able to use the USAEC study to share lessons learned.

DESCRIPTION

The USAEC study will expand and update the Army's initial Andrulis Report of environmental technology requirements. It will also identify those technology needs that can be immediately addressed with off-the-shelf technologies currently available within private industry. The environmental technology requirements survey will be conducted in several phases. The first phase will consist of the planning and development of a user survey format along with an extensive review and retrieval of survey information from existing data sources. The second phase will consist of a continuation of the data collection primarily through the effort of on-site visits with the Army user community at installations. This phase will also consist of processing the final results and transitioning them for further cost-benefit analysis and ranking. The third phase will consist of the planning, development, and implementation of an on-going methodology to automate the process for maintaining a current set of user environmental technology requirements.

Information defining cost and performance information of existing state-of-the-art technologies is being collected and can be used to support the development of future improved technologies.

The final results of this project effort will be made available in electronic form called the Army's Technology Needs Survey (TNS). This data will be in a Microsoft Access database with a Visual- Basic front end application. Draft copies are made available in advance of the final product upon request.

This project is in direct support of technology development for specific Army requirements. As such, it is not directly responsible for the demonstration or fielding of specific technologies.

APPLICABILITY

This project effort supports every Army environmental technology requirement by serving to update, expand, and clarify the set of technology requirements created in the 1993 Andrulis Report.

ACCOMPLISHMENTS AND RESULTS

The survey and update efforts will be completed second quarter of FY 97. Cost and perfomance information regarding existing state-of-the-art technologies was collected. This information will be used to support future improved technologies development. The third phase is being investigated and planned.

FOLLOW-ON PROGRAM REQUIREMENTS

- Present Final Results of the TNS User Requirement Surveys to each Pillar Technology Team for Review and Comment
- Complete the Final Report and Close out the Contract Effort
- Plan and organize Phase III efforts

POINT OF CONTACT

Edward Engbert

PROGRAM PARTNERS

U.S. Army Environmental Center

PUBLICATIONS

Army Technology Needs Survey

U.S. Army National Environmental Technology Test Sites (NETTS) Program

In 1990 Congress established the Strategic Environmental Research and Development Program (SERDP) to expedite the transfer of environmental technologies from basic research and early developmental stages to actual field demonstration. SERDP established the NETTS Program, a Tri-Service/EPA partnership, to facilitate the demonstration, evaluation and to identify potentially cost effective technologies for scale up or implementation by the user community.

PURPOSE

To expedite demonstration, evaluation, and transfer of effective environmental technologies aimed at characterizing, remediating, or monitoring sites contaminated with explosives and other aromatic constituents.

BENEFITS

Immediate benefits that can be derived from an integrated demonstration and evaluation program include: (1) identifiing achievable and cost -effective cleanup goals; (2) establishing a research and development platform for remediation technologies advancement; (3) accelerating innovative technologies acceptance as presumptive remedies for reducing cleanup time and costs; (4) well-documented engineering packages, where appropriate for the broader application of effective technologies; (5) return on investment and cost savings of SERDP-sponsored and other technology demonstrators; and (6) advancing the understanding of contaminants' fate and transport.

In addition, by including private technology demonstrators, regulators, users, and the public in the demonstration planning process, each NETTS test location provides opportunities for identifying and developing acceptable cost-effective technologies for transfer to other Government agencies and the private sector, resulting in lower remediation costs for the government.

TECHNOLOGY USERS

Federal and private sector facilities.

BACKGROUND

The Strategic Environmental Research and Development Program (SERDP) asked each service to establish and manage test sites that would provide private sector and Federal technology developers a place to test their technologies. The Army chose the Volunteer and Louisiana Army Ammunition Plants as their test sites. This project's funds have gone to fully characterizing the sites and providing a basic infrastructure, so that the technology developers have facility, utility, and analytical access. Under the auspices of SERDP, NETTS test sites focus on solving military-unique priority contaminant situations and concerns.

DESCRIPTION

The technical approach employed by U.S. Army NETTS program entailed in-depth delineation and characterization of contaminant and hydrogeologic conditions at Volunteer Army Ammunition Plant (VAAP) and other Army installations and facilities for the purpose of providing viable test locations for comparative demonstration, evaluation, and analysis of a technology's theory, design, and operation. Site characterization efforts conducted involved determining actual volumes and concentrations of contaminated soil in order to designate areas for comparative demonstration. Data from these investigations and relatively recent Installation Restoration groundwater sampling investigations were incorporated into a comprehensive site characterization document. Useful aspects of the site characterization document that assist principal investigators and project managers in making project decisions are the identification of the presence of other analytes

such as metals which may interfere with a particular technology's performance and descriptions of environmental conditions at the test sites through tables, charts, graphs and three dimensional drawings.

To broaden the spectrum of explosives and hydrogeological settings two other locations in close proximity to the VAAP have been selected for technology demonstrations; the Holston Army Ammunition Plant (HSAAP) and the Milan Army Ammunition Plant (MAAP). HSAAP located in northeastern Tennessee is the only active production site for HMX and RDX in the U.S. and has explosives - contaminated groundwater. MAAP located in west Tennessee has soil and municipal drinking water contamination. Several biotreatment technologies for treating explosive-contaminatedsoil have been developed in the private sector. Available data from laboratory testing indicate that these technologies have great potential to be cheaper or more efficient than currently available technologies. In order to assess these technologies, a comparative demonstration has been scheduled to provide cost and performance data. The study will provide the private sector with an opportunity to demonstrate their technology at a contaminated site and assist in marketing their technology throughout the Army community. In addition, this effort will assist MAAP in the selection of a specific vendor for the final remedial action at the site. Analytical support for demonstrations will be provided by the NETTS analytical laboratory at VAAP and the SERDP NETTS Guidelines for Quality Technology Demonstrations protocol will be utilized during the demonstration process.

The Army NETTS analytical laboratory located on site at the VAAP National Test Location (NTL) which has been validated by the USAEC, is dedicated to technology demonstration analytical support but may also be utilized by DoD components such as Base Realignment and Closure (BRAC) or Installation Restoration (IR) project managers for QA/QC. The NETTS laboratory provides expedient sample analysis and turn around times, provides an effective platform for ensuring QA/QC on-site, provides significant cost savings for laboratory analysis and is available to all NETTS NTLs. During technology demonstrations cost and performance parameters for various environmental characterization and remediation technologies are monitored and recorded. Cost and performance data are collected in conformance with the structure, guidelines and criteria identified through the SERDP's McClellan effort and are subsequently submitted for incorporation into the NETTS Cost and Performance Database. In this manner critical technology demonstration data can be accessed for further analysis or for incorporation in cleanup strategies where cost effective and innovative techniques are sought.

At the conclusion of each demonstration, an Application Analysis Report (AAR), prepared by the Principal Investigator (PI), and a Technology Application Analysis Report (TAAR), prepared by the Test Location Manager (TLM), are published. These reports, respectively, provide both the demonstrator's and TLM's analysis and interpretation of the technology's demonstration results and potential for implementation at actual cleanup sites. Where appropriate, engineering design, fabrication and procurement guidance will be provided to potential users, regulators, public and commercial interest.

Once a given technology is fielded, the ETD scientists and engineers remain committed to support the user in implementation, expansion, or problem solving.

APPLICABILITY

Andrulis Report Requirements:

- 1.2.a Explosives in Groundwater
- 1.2.b Organics in Groundwater

- 1.3.a Remediation of Explosives in Soils
- 1.3.b On-site Treatment of Organics Contaminated Soil
- 1.3.c Explosives/Organics Contaminated Sediments
- 1.3.m Soil Bioremediation
- 1.3.h Determine Natural Attenuation Rates of Army Unique Compounds

ACCOMPLISHMENTS AND RESULTS

During FY93 the USAEC screened several candidate facilities and installations from the Installation Restoration Program for the purpose of selecting suitable explosives NTLs. By the end of FY94 the USAEC negotiated and coordinated the establishment of VAAP as the Army's first NETTS NTL. In FY95 the Army conducted in-depth site characterization, developed test site infrastructure and performed administrative, logistical, and oversight functions necessary to establish VAAP as a NTL. These activities included: conducting site and environmental assessments; permit and regulatory review; development of site specific management and health and safety plans; test site infrastructure development; on-site analytical laboratory set-up and validation; and coordination with potential government and private industry technology demonstrators.

The first project to utilize the VAAP test site for the purpose of a field test was Site Characterization and Penetrometer Systems (SCAPS). During summer 1995 sensors developed to detect explosives in soil and groundwater were field tested at VAAP with additional prove-out completed during summer 1996.

Another first was realized during early 1996 when the Army NETTS program hosted its first private industry participant. From January 1996 to May 1996 the ECOCHOICE system developed by Eco Purification Systems was demonstrated. The ECOCHOICE system is based on catalytic oxidation of pollutants on a fixed bed reactor.

During summer 1996 two additional efforts, both SERDP funded, were performed at the VAAP NTL. The first effort which was a collaborative effort between the U.S. Environmental Protection Agency, the U.S. Army Center for Health Promotion and Preventive Medicine and the Virginia-Maryland Regional College of Veterinary Medicine. The effort was focused on studying the effects of explosives and heavy metals contamination on wildlife with the objective of identifying bioindicators of sublethal stress in rodents, fish and amphibians. The second effort involved a phytoremediation pilot study which tested the ability of various submerged and emergent aquatic plants to remove nitroaromatic compounds from groundwater. The study examined the impact of dynamic system operation on contaminant removal rate as well as the effects of various hydraulic retention times.

The USAEC also managed the development and publication of the Guidelines for Quality Technology Demonstrations document which will assist the DoD Tri-Services and EPA NETTS partners in their efforts to implement common demonstration standards and uniform analytical protocols. The Army chose the Volunteer and Louisiana Army Ammunition Plants as their test sites.

Demonstrated technologies should be amenable to a soil environment of a clay-loam overburden underlain by karst features.

RESOURCE SUPPORT

SERDP

Follow-On Program Requirements

MARCH 1997

1. Provide site support for USAF Bioreactor demo startup activities.

2. Site support for startup of Phase II of WES phytoremediation demonstration.

3. Continued contact POC for Milan Bio-Cookoff to discuss sampling and analysis needs.

4. Obtain AEC validation for analysis of TKP and TKN utilizing Lachat AIA.

5. Install and upgrade to operational status GC instrumentation and moisture analyzer acquired from INAAP.

6. Link VAAP NETTS homepage to AEC and SERDP pages by application to appropriate POC.

7. Final discussions regarding degree and type of laboratory support to be provided to Milan AAP Bio-Cookoff demonstrations.

8. Attendance at TLM Meeting tentatively planned per quarter.

9. Continue search via internet and military and governmental organizations for funded technology developers in need of demonstration site.

Continue surveying for potential Cooperative Research and Development Agreement (CRADA) partners and funding sources for unfunded technology developers.

APRIL 1997

1. Provide site support for USAF Bioreactor demo onsite operation.

2. Continued laboratory support for Milan AAP Bio-Cookoff demonstrations.

3. Site support for Phase II of WES Phytoremediation Demonstration.

4. Continue search via internet and military and governmental organizations for funded technology developers in need of demonstration site.

5. Continue surveying for potential CRADA partners and funding sources for unfunded technology developers.

6. Submittal of Final Reports from Eco-Purification Systems USA, Inc., (EPS), Biomarker, WES phytoremediation and SCAPS onsite activities to SERDP at Comprehensive Review.

7. Screening of AEC/NETTS video at SERDP Comprehensive Review Committee.

MAY 1997

1. Write SOPs for additional analysis using gas chromatograph GC instrumentation and moisture analyzer.

2. Provide site support for USAF Bioreactor demo onsite operation.

3. Continue site support for Phase II of WES Phytoremediation Demonstration.

4. Laboratory support for Milan AAP Bio-Cookoff demonstrations.

5. continue search via internet and military and governmental organizations for funded Technology developers in need of demonstration site.

6. Continue exploration of funding sources for unfunded technology developers and

of potential CRADA partners.

JUNE 1997

1. Complete writing of SOP for additional analysis using GC instrumentation and moisture analyzer.

2. Provide site support for USAF Bioreactor demo onsite operation.

3. continue site support for Phase II of WES Phytoremediation Demonstration.

4. Laboratory support for Milan AAP Bio-Cookoff demonstrations.

5. Attendance at TLM meeting tentatively planned per quarter.

6. Continue search via internet and military and governmental organizations for funded technology developers in need of demonstration site.

7. Continue surveying for potential CRADA partners and funding sources for unfunded technology developers.

JULY 1997

1. Provide site support for USAF Bioreactor demo onsite operation.

2. Continue site support for Phase II of WES Phytoremediation Demonstration.

3. Laboratory support for Milan AAP Bio-Cookoff demonstrations.

4. Continue search via internet and military and governmental organizations for funded technology developers in need of demonstration site.

5. Continue exploration of funding sources for unfunded technology developers and of potential CRADA partners.

AUGUST 1997

1. Provide site support for USAF Bioreactor demo onsite operation.

2. Laboratory support for Milan AAP Bio-Cookoff demonstrations.

3. Continue site support for Phase II of WES Phytoremediation Demonstration.

4. Continue surveying for potential CRADA partners and funding sources for unfunded technology developers.

5. Continue surveying for potential CRADA partners and funding sources for unfunded technology developers.

SEPTEMBER 1997

1. Provide site support for USAF Bioreactor demo onsite operation.

2. Continue site support for Phase II of WES Phytoremediation Demonstration.

3. Follow-up documentation for laboratory support for Milan AAP Bio-Cookoff demonstrations.

4. Attendance at TLM meeting tentatively planned per quarter.

5. Continue search via internet and military and governmental organizations for funded technology developers in need of demonstration site.

6. Continue surveying for potential CRADA partners and funding sources for

unfunded technology developers.

Prepare and update materials for 3rd Annual SERDP Symposium.

OCTOBER 1997

1. Provide site support for USAF Bioreactor demo onsite operation.

2. Final reporting from NETTS laboratory and close-out of Phase II of WES Phytoremediation Demonstration.

3. Continue search via internet and military and governmental organizations for funded technology developers in need of demonstration site.

4. Continue surveying for potential CRADA partners and funding sources for unfunded technology developers.

Finalize preparations for 3rd Annual SERDP Symposium.

POINT OF CONTACT

A.J. Walker

PROGRAM PARTNERS

U.S. Army Environmental Center

Louisiana Army Ammunition Plant, Louisiana

Holston Army Ammunition Plant, Tennessee

Milan Army Ammunition Plant, Tennessee

Volunteer Army Ammunition Plant, Tennessee

PUBLICATIONS

Demonstration of Defense National Environmental Technology Demonstration Program, Guidelines for Quality Technology Demonstrations, SERDP, December, 1995.

Volunteer Army Ammunition Plant DoD National Environmental Technology Test Sites Management Plan, USAEC, March 1996.

Site Characterization of Volunteer Army Ammunition Plant Technology Demonstration Area, USAEC, December 1995.

Environmental Assessment for Establishment of a National Test Location at Volunteer Army Ammunition Plant, USAEC, November 1995.

Heath and Safety Plan - National Environmental Technology Test Sites, Volunteer Army Ammunition Plant, USAEC, June 1995.

Quality Assurance Project Plant - National Environmental Technology Demonstration Program Test Site, Volunteer Army Ammunition Plant, USAEC, May 1995.

Louisiana Army Ammunition Plant DoD/National Environmental Technology Test Sites Management Plan, USAEC, March 1996.

Environmental Assessment for Establishment of a National Test Location at Louisiana Army Ammunition Plant, USAEC, November 1995.

Heath and Safety Plan - National Environmental Technology Test Sites, Louisiana Army Ammunition Plant, USAEC, November 1995.

SOIL

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Bioventing of POL Contaminated Soils

Many operational facilities have POL contaminated soils. Excavation for remediation often disrupts ongoing operations. Bioventing offers an alternative to excavation and incineration, relying on existing microorganisms to remediate the waste.

PURPOSE

To transfer bioventing technology to the Army from the Air Force for use in the remediating POL contaminated sites on Army installations. Demonstrate and promote intrinsic remediation, bioventing, and bioslurper technologies within the Army.

BENEFITS

A less expensive remediation technique for POL contaminated soils.

TECHNOLOGY USERS

Army installation and remediation managers.

BACKGROUND

The Army has numerous sites that are contaminated with petroleum, oils and lubricants (POLs). Sites where contaminants may be found include aircraft areas, maintenance areas, leaking storage tanks, burn pits, chemical disposal areas, disposal wells and leach fields, landfills and burial pits, fire fighting training areas ad surface impoundments.

Contamination by POL contaminants in the unsaturated (vadose) zone exists in four phases: vapor in the pore spaces; sorbed to subsurface solids; dissolved in water; or as Non-Aqueous Phase Liquid (NAPL). The nature and extent of transport are determined by the interactions among contaminant transport properties (e.g., density, vapor pressure, viscosity, and hydrophobicity) and the subsurface environment (e.g., geology, aquifer mineralogy, and ground water hydrology).

Common treatment technologies for POLs in soil include excavation and landfilling, biodegradation, incineration, soil vapor extraction (SVE), and low temperature thermal desorption. Implementing of in-situ remediation techniques would greatly reduce costs associated with the cleanup of POL contaminated sites.

DESCRIPTION

This technology was developed by the Air Force Center for Environmental Excellence (AFCEE) Bioventing Initiative. This effort will consist of treatability studies and pilot scale demonstrations of bioventing at various sites. These pilot demonstrations are intended to lead to large scale demonstrations, which will provide accurate performance and cost data for the process. Testing bioventing under real scenarios is intended to build confidence in the technology and increase its awareness within the Army user community.

Based on AFCEE and commercial applications of this technology, costs for operating a bioventing system range from \$10 to \$60 per cubic yard. The time required to cleanup a site ranges from 1 to 5 years to remove benzene, toluene, ehtylbenzene, xylene (BTEX) constituents and two to ten years to remove total petroleum hydrocarbons (TPH). Factors that affect the cost and duration include contaminant type and concentration, soil permeability, well spacing and number, pumping rate, and off-gas treatment. For these reasons, initial treatability studies need to be performed to determine bioventing's effectiveness at each site. Bioventing does not require expensive equipment and can be left unattended for long periods of time. Typically, only periodic maintenance and monitoring is conducted.

ACCOMPLISHMENTS AND RESULTS

Three bioventing pilot demonstrations are currently operating. Two of the pilot systems should provide full scale cleanup at their sites (Fort Rucker and Fort Bliss). The Fort Carson pilot system is being scaled up to provide full scale remediation .

LIMITATIONS

The time required to cleanup a site ranges from 1 to 5 years to remove BTEX constituents and two to ten years to remove TPH.

FOLLOW-ON PROGRAM REQUIREMENTS

Issue contract to demonstrate and promote use of intrinsic remediation and bioventing and bioslurper technologies to the Army.

POINT OF CONTACT

Gene Fabian

PROGRAM PARTNERS

U.S. Army Environmental Center

Fort Bliss, Texas

Fort Rucker, Alabama

Fort Carson, Colorado

Catalyzed Hydrogen Peroxide Treatment of 2, 4, 6-Trinitrotoluene in Soils

Army installations face high costs to cleanup soil contaminated by explosives from past operations. Advanced oxidation processes using catalyzed hydrogen peroxide can treat TNT in-situ. In-situ treatment is a cost effective alternative to current invasive methods of treating explosives-contaminated soil.

PURPOSE

To determine if an advanced oxidation of TNT *in-situ* by a catalyzed hydrogen peroxide process (Fenton's reagent) may provide an effective, cost saving, and safe alternative to current invasive practices.

BENEFITS

Capability to treat TNT explosives-contaminatedsoil *in-situ.*

TECHNOLOGY USERS

All cleanup and range personnel.

BACKGROUND

Explosives contamination in soils and groundwater is a common environmental problem at many military and civilian installations. TNT constitutes a large portion of this contamination. Past production and handling of conventional munitions has left explosives in soils at many Army industrial installations. Use of explosives as part of military training also contributed to the explosives-contaminated soil problem. Depending on the concentrations of explosives - mainly trinitrotoluene (TNT), cyclonite (RDX) and cyclotetramethylene (HMX) - the effected soils can pose reactivity and toxicity hazards. Because these explosives can migrate from the soils into groundwater, the effected soils should be treated to eliminate any threat to human health or the environment.

DESCRIPTION

In solution, TNT was rapidly degrading after three sequential additions of H_2O_2 and Fe^{2+} in a molar (M) ratio of 25:15:1 (H_2O_2: Fe^{2+}:TNT) at pH between 2.5 and 3 in solution. Three oxidation products were formed and found to be readily degradable, two of the products were trinitrobenzaldehyde (TNBA) and 3, 5-dinitroaniline. Fenton's reagent also readily treated three soils that were amended with TNT (446 mg/kg). In the presence of 1M H_2O_2 and 10 mM Fe^{2+}, 97% of TNT could be oxidized in all three soils after 8 hours. Further treatments with 1M H_2O_2 resulted in further TNT degradation, 98-99%.

APPLICABILITY

Andrulis Report Requirement:

1.3.a Remediation of Explosives in Soil

ACCOMPLISHMENTS AND RESULTS

All observed oxidation products were degradable in soil treatments, with one less degradable presumably due to strong partition to soil surfaces. Fenton's reagent oxidation is a promising remediation tool for decontaminating residues.

LIMITATIONS

Evaluate this treatment process on field contaminated soil and optimize this technology to make it cost effective.

FOLLOW-ON PROGRAM REQUIREMENTS

Technology transfer of this information.

POINT OF CONTACT Tony Perry

PROGRAM PARTNERS U.S. Army Environmental Center

University of Delaware, Department of Civil and Environmental Engineering

PUBLICATIONS 1996 Report available.

Cost and Design for Application of Biotreatment Technologies for Explosives-Contaminated Soils

Army industrial installations face high costs to cleanup soil contaminated by past explosives operations. Remediating these sites is a prerequisite for beneficial reuse by the Army and protection of the environment. These installations require cost-effective techniques to treat large volumes of explosives-contaminated soils. The U.S. Army Environmental Center has developed cost and design information on two bioremediation alternatives to incineration that can help in contracting for these and other innovative cleanup technologies.

PURPOSE

To estimate the costs for implementing biotreatment alternatives and offer lessons learned in contracting for innovative technologies.

BENEFITS

Will establish the standard for providing sufficient design and technical data to generate reliable bids for using innovative technologies in cleanup.

TECHNOLOGY USERS

DoD installations with explosives-contaminated soil.

BACKGROUND

One of the Army's greatest cleanup challenges is explosives-contaminated soils. Forty installations have reported explosives contamination at one or more sites, with total volumes estimated at over 1.2 million tons. The U.S. Army Environmental Center (USAEC) has dedicated years to developing and fielding biotreatment alternatives to the conventional technology of high temperature incineration. Two biotreatment processes have been validated in the field:

Windrow Composting was successfully demonstrated to be effective in treating explosives-contaminatedsoils at Umatilla Army Depot Activity, Oregon (UMDA). Because of the success of the demonstration, windrow composting was chosen as the remediation technique for explosives-contaminated soil in a 1992 Record of Decision for a Superfund site at UMDA. The cleanup was successful, finishing a year ahead of schedule, with over 80% of confirmation samples showing treatment to nondetectable levels.

Soil Slurry biotreatment or "bioslurry", another innovative technology for remediating explosives-contaminated soils, was demonstrated successfully at Joliet Army Ammunition Plant in 1995 and 1996 and is being demonstrated at Iowa Army Ammunition Plant as a treatment technology.

DESCRIPTION

Bioremediation is now available as an alternative cleanup remedy for explosives-contaminated soils. Bioremediation boosts the activity of naturally occurring microorganisms to degrade hazardous substances in soil or sediment into nontoxic materials. The microorganisms can digest a number of different materials and the process is enhanced by tailoring site conditions for the existing microorganisms.

Windrow Composting:

Because of the modest equipment and monitoring requirements, windrow composting is a cost-effective technology with a high degree of treatment effectiveness for explosives-contaminated soils at a low process cost.

Windrow composting mixes the soil with compost in long piles known as windrows. To facilitate the microbial growth, carbon sources such as manure,

straw, alfalfa, and other agricultural products are added. To facilitate aeration and heat control, windrows are turned periodically using a compost turner. Moisture content, windrow oxygen level, and temperature are easily monitored.

Bioslurry:

For sites requiring greater process control, more complete degradation, or where the cost of importing compost amendments is prohibitive, bioslurry is another bioremediation option. The contaminated materials are mixed into a slurry to allow contact between the microorganisms and the contaminants. Because conditions are optimized for the microorganisms, slurry processes are faster than many other biological processes. The treated slurry is suitable for direct land application, similar to composted soils.

APPLICABILITY

Andrulis Report Requirements:

- 1.3.a Remediation of Explosives in Soil
- 1.3.b On-Site Treatment of Organics Contaminated Soils
- 1.3.c Explosives/Organics Contaminated Sediments
- 1.3.m Soil Bioremediation
- 2.3.d Develop Alternative Technologies to Mitigate Contaminated Soil

ACCOMPLISHMENTS AND RESULTS

In 1992, USAEC demonstrated windrow composting to reduce explosive concentrations over 99% and toxicity over 90-98%. Follow on studies charted the success of the first full scale windrow composting application at UMDA. A new report documents the remedial design and the determined unit cost.

In 1995, slurry phase biotreatment demonstrated a removal rate over 99% and a high degree of mineralization at Joliet Army Ammunition Plant, Illinois. Studies in support of a Feasibility Study at Iowa Army Ammunition Plant developed designs and cost estimates for full scale application of aerobic and anaerobic bioslurry processes.

Based on what was learned in the field demonstrations about process performance and construction and operating costs, USAEC is able to provide full scale concept design and cost estimates to help users apply these processes at their sites. For treatment of 10,000 yd^3 (13,000 tons) of explosives-contaminated soil, complete process costs for composting range from $250 to $299/ton and bioslurry costs $230 to $370/ton. These are half the cost of incineration; $740/ton. This can be compared to the treatment costs of $314/ton for a proprietary anaerobic bioslurry process.

LIMITATIONS

Disposition of the treated soil is an important part of bioslurry process costs. Consideration of disposed soil placement is affected by risk-based goals and future land use. If dewatering, and thus water treatment, is required, cost will increase.

POINT OF CONTACT

Mark Hampton/Wayne Sisk

PROGRAM PARTNERS

U.S. Army Environmental Center

Umatilla Army Depot Activity, Oregon

Iowa Army Ammunition Plant, Iowa

Joliet Army Ammunition Plant, Illinois

PUBLICATIONS

Cost Report: Windrow Composting to Treat Explosives-ContaminatedSoils at Umatilla Army Depot Activity (UMDA); Report No. SFIM-AEC-ET-CR-96184, September 1996.

Field Demonstration of Slurry Reactor Biotreatment of Explosives-Contaminated Soils; Report No. SFIM-AEC-ET-CR-96178, April 1997.

Windrow Composting Demonstration for Explosives-ContaminatedSoils at the Umatilla Depot Activity Hermiston, Oregon; Report No. CETHA-TS-CR-93043, August 1993.

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Follow on Reactivity Study of Primary Explosives in Soil

Soils contaminated with explosives must be considered reactive unless research has shown them not to be. Determining the actual level for primary explosives will allow remediation managers to protect the workers while conserving resources for the remediation.

PURPOSE

To conduct tests at various primary explosive concentrations and moisture levels, establishing a safety threshold reactivity level, and developing a database at higher confidence levels.

BENEFITS

The study will help increase understanding of the overall safety threshold reactivity levels of primaries. This information will help determine safe concentration levels for personnel to investigate primary explosive-contaminated soil areas on Army installations.

Study results will also be used by the Department of Transportation to establish DOT hazardous waste classification for primary explosive waste and DoD Explosive Safety Board, and private industries involved in manufacturing of primary explosives.

TECHNOLOGY USERS

Army industrial facilities and Formerly Used Defense Sites.

BACKGROUND

Since World War I, munitions have been manufactured in the United States using a variety of energetic materials, including propellants, explosives, and pyrotechnic (PEP) materials. Many manufacturing sites contain explosives-contaminated soil as a result of prior and existing operations, including load, pack and repack, maintenance, storage, disposal, and demilitarization. Some of these sites contain primary explosives, such as lead azide, lead styphnate, and nitroglycerin (NG).

The Army's site restoration criteria regarding cleanup priority and technology would be incomplete without safety data for soils contaminated with primary explosives (i.e., lead azide, lead styphnate, and NG). This data will be used to develop protocols for sampling, handling, cleanup alternative, and transportation of explosive-contaminated soils.

The U.S. Army's Remedial Investigation and Feasibility Study (RI/FS) activities at installations currently contaminated with primary explosives have been suspended until the specifics outlined under the following "Applicability" section are complete. The DOT must establish hazardous-waste classifications for primary explosive wastes.

The Army's mission for site cleanup includes propellants, explosives, pyrotechnics, unexploded ordnance, industrial waste, and hazardous waste. DoD site cleanup goals cannot be accomplished without a characterization of soils contaminated with primary explosives.

The Army will use the study results to investigate installations currently undergoing RI/FS investigations (i.e., Picatinny Arsenal, New Jersey, Joliet Army Ammunition Plant, Illinois, Sunflower Army Ammunition Plant (SAAP), Kansas.).

DESCRIPTION

This study will enhance the military's mission, goals, and readiness through meeting CERCLA and RCRA requirements of controlling hazardous waste from cradle to grave. The military must have a thorough understanding of the wastes generated from different activities conducted under their control to be in

compliance with CERCLA and RCRA. This is especially true in the area of explosives, which have significant safety concerns along with environmental concerns.

The technical approach of the Follow-On Reactivity Study is:

- Evaluate existing reactivity testing procedures used for primary explosives to determine applicability and develop alternative reactivity testing protocols, if appropriate.
- Develop a data base at higher confidence levels to verify the unqualified positive reaction that occurred at 7 % (see "Accomplishments").
- Establish threshold initiation-level values for these primary explosives and establish safe-handling criteria.
- Investigate possible explosive segregation or concentration of wet samples (moisture levels).
- Develop optimal burn times and publish standard procedures.
- Plot probit graphs and calculate confidence levels.
- Evaluate primary reactivity levels in different soil types and fill data gaps.
- Evaluate effects of soil compactness and soils contaminated with larger primary explosives agglomerates.
- Develop a procedure to collect and prepare samples for analysis.

APPLICABILITY

Andrulis Report Requirement:

- 1.5.g Hazard/Risk Assessment of Military Unique Compounds

ACCOMPLISHMENTS AND RESULTS

Phase I reactivity study tests (#8 Cap, Bonfire, Zero Gap, and DDT), funded in 1994, were conducted with a 3 - 14% (by weight) mixture of primary explosives in soil. Lead azide was selected as the primary of greatest concern because it had the lowest reactivity levels of lead azide and lead styphnate. The lowest explosive concentration that recorded one unqualified positive reaction occurred with 7% lead azide in dry soil in the Bonfire test.

No other positive reaction occurred below 13 percent in soil for lead azide or lead styphnate. This study provided basic information and recommended a 5% safety threshold reactivity level for lead azide and 10% for NG. Moisture levels appeared to affect reactivity. Mercury fulminate was not included in this study because few sites have mercury fulminate contamination.

FOLLOW-ON PROGRAM REQUIREMENTS

The issues listed in the technical approach must be addressed before these safety threshold reactivity levels can be adopted.

POINT OF CONTACT

William Houser

PROGRAM PARTNERS

U.S. Army Environmental Center

Department of Defense Explosive Safety Board

Defense Evaluation Support Activity

Department of Transportation

Global Environmental Solution (Alliant Techsystem Company)

TRW, Inc.

PUBLICATIONS

Reactivity Testing of Primary Explosives Final Report Number: SFIM-AEC-TS-CR-94057 Contract Number: DACA31-91-D-0079 Date: May 1994.

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In-situ Electrokinetic Remediation for Metal Contaminated Soils

Remediating heavy metals in environmentally sensitive areas presents additional challenges to DoD. Often, these areas are used as wildlife habitats and by the public for recreation. Technologies such as electrokinetic remediation allow for non-intrusive remediation.

PURPOSE

To conduct a joint project with the Navy to demonstrate the use of electrokinetics to cleanup heavy metals in a wetland environment.

BENEFITS

Electrokinetic remediation is being demonstrated because of its potential to be less invasive in ecologically sensitive areas and more cost effective than other metals removal technologies.

TECHNOLOGY USERS

Military installations with metals contaminated soils.

BACKGROUND

Military activities are on of the primary contributers to metals-contaminated soil. Military operations, such as small arms training, electroplating and metal finishing operations, explosive and propellant manufacturing and use, and using lead-based paint on ships and at military facilities, has resulted in vast of land contaminated with metals. As a result, there is a need to develop cost-effective remediation tools. Current technologies include solidification/stabilization methods and excavation, followed by landfilling of the contaminated soils. These methods are very expensive and may only provide temporary solutions to the contaminant problem. A low cost method of extracting the contaminants from the soil without soil excavation is needed to effectively address this problem. Electrokinetics has been identified as a possible method of performing an in-situ extraction of the metals contaminants from the soils.

DESCRIPTION

Electrokinetic remediation is being demonstrated because of its potential to be less invasive in ecologically sensitive areas and more cost effective than other metals removal technologies. Heavy metals are an environmental problem, especially in an aqueous environment. Because metals are charged particles, it is possible to use an electric current to move those particles.

The site selected for full scale electrokinetic soil remediation demonstration is at the Point Mugu Naval Air Weapons Station (NAWS) in Ventura County, California. The installation is approximately 50 miles northwest of Los Angeles and comprises approximately 4,500 acres. NAWS Point Mugu is situated in the western portion of the Ventura Basin with the Santa Monica Mountains located directly to the east of the installation.

The demonstration area is referred to as "Site 5". This is a large area where many industrial and military operations were conducted. The specific area of study is approximately 1/2 acre in and around two waste pit lagoons located in the center of Site 5. These pits are unlined and were used between 1948 and 1978 to receive wastewater discharge. The wastewater discharged into the pits included up to 60,000-gallons of photovoltaic fixer, small quantities of organic solvents, rocket fuel, and approximately 95-million gallons of plating rinse water. The waste pits are located in a tidal marsh area. The waste pits measure approximately 30 by 90 feet and range in depth from 4 to 5.5 feet. The pits are surrounded by an elevated berm approximately two feet above the water level. The waste pit lagoons typically contain standing water, which fluctuates with the tides. The area around

the pits is bounded by Beach Road on the south side and the tidal marsh on the remaining three sides.

An emergency action was performed in 1994 when approximately 117 cubic yards of material was removed from the pits to limit exposure of resident and migratory birds and to reduce the contamination source that may impact the surface and groundwater. This area is inhabited by the light-footed clapper rail, a Federal and state listed endangered species, as well as other species. Prior to the emergency removal, the levels of chromium, cadmium, copper, nickel, and silver were high. After the emergency action, surface sampling in the pits indicated that cadmium and chromium levels still exceeded Total Threshold Limit Concentration described in the California Code of Regulations (California Code of Regulations, Title 22, Section 66261.24). California will not allow any further soil excavation from this site. Other potential chemical contaminants of concern at this site are arsenic, beryllium, Aroclor260, tetrachloroethane, trichloroethene, manganese, and fluoride. Due to the state and Federally listed endangered species, there are restrictions on work activities.

APPLICABILITY

Andrulis Report Requirements:

- 1.4.d -- Lead Contamination
- 1.3.e -- Soil Inorganic
- 1.5.f -- Alternatives to pump and treat

Cadmium and Chromium levels exceeded Total Threshold Limit Concentration described in the California Code of Regulations (California Code of Regulations, Title 22, Section 66261.24)

ACCOMPLISHMENTS AND RESULTS

- The U.S. Army Waterways Experiment Station (WES) Treatability study is underway
- Initial site characterization sample plans have been approved and field sampling has been completed
- Electrokinetics market research is in progress and near completion
- Demonstration plan and regulatory permits are being developed
- Site preparation plans (i.e. barrier wall, site facilities layout, services requirements, etc.) are nearing completion

FOLLOW-ON PROGRAM REQUIREMENTS

- WES Treatability Study
- Initial Site Characterization
- Electrokinetics Market Research
- Regulatory Permit
- Demonstration Test Plan
- Site Preparation
- Electrokinetics System Installation
- Technology Monitoring and Site Management

POINT OF CONTACT

Gene Fabian

PROGRAM PARTNERS

U.S. Army Environmental Center

Point Magu Naval Air Weapons Station

U.S. Army Waterways Experiment Station

Phytoremediation of Lead in Soil

Lead in soil may place the continued operation of training ranges in jeopardy as the lead may leach into the groundwater or surface water. Phytoremediation, which is the use of plants, offers a reliable method for removing lead from the soil.

PURPOSE

To demonstrate the effectiveness of lead site remediation in soil using phytoremediation.

BENEFITS

Benefits from successful phytoremediation of lead-contaminated sites are lead removal from the soil and lead recovery for off-site disposal or recycling, which allows for non-restrictive site use. Future costs of monitoring and maintaining a hazardous site or landfilled hazardous waste would be eliminated, in addition to removing the long-term liability associated with hazardous waste. Phytoremediation minimizes site disturbance, which limits contaminants dispersal, in contrast to excavating and landfilling soil. The phytoremediation cost is much less than conventional methods. Phytoremediation of one acre to a depth of 50 cm is estimated to cost $60,000 to $100,000, whereas excavating and landfilling the same soil volume is estimated to cost from $400,000 to $1,700,000.

TECHNOLOGY USERS

Army and DoD installations with lead contaminated soil will benefit from this technology.

BACKGROUND

Disposal and burning of scrap ammunition and powder, firing range use, and similar activities have resulted in lead contaminated soils at a number of DoD installations. Current treatments are excavation and landfilling, soil washing, or immobilization through chemical treatment. As a result, the metals are neither destroyed or reclaimed. Liability, long term monitoring, and restricted land use all contribute to high costs. Phytoremediation, specifically the technique of phytoextraction, is an alternative technology. Phytoextraction is the use of plants to pull metals out of the soil solution and into the plant structure. This project will conduct process optimization and treatability studies to determine the most efficient plant species, leachate concerns, levels of soil amendments, amendment application, and fertilization effects on lead accumulation and extraction. Efforts from this project can be leveraged into a field demonstration.

DESCRIPTION

This effort is being conducted for USAEC by the TVA. This project is divided into five phases. Phase 1 is the development of the process optimization test plan. Phase 2 is the site screening, soil collection, and metal analysis. During this phase contaminated soil at various sites will be considered for use, selected, collected, and analyzed for pH and heavy metals content. This soil will be used throughout the remainder of the studies. Phase 3 entails preliminary studies consisting of chelate screening and chelate application. Phase 4, the greenhouse studies, will include plant screening and foliar application of nutrients. A third substudy in this phase will take the most effective plant species, soil amendment treatments, and fertilizer levels from the two previous greenhouse studies in larger soil volumes to more closely simulate soil leaching in field conditions. This study will also incorporate an after harvest replanting to determine the effect of lead and residual chelate on seed germination and plant growth, lead leaching by residual chelate, and lead removal by subsequent planting. Phase 5 will be the final report.

Two soil types, one clayey and one sandy, have been selected from the Sunflower

Army Ammunition Plant. These soils have been excavated in bulk, approximately 1000 kg of each type, and returned to TVA.

APPLICABILITY

Andrulis Report Requirements:

- 1.4.d Lead Contamination
- 1.3.e Soil Inorganic
- 1.4.c Heavy Metals

1.I.4.j Improved Isolation and Treatment of Heavy Metals in Soil - Navy

1.2010 Heavy Metals in Excavated Soil Treatment - Air Force

ACCOMPLISHMENTS AND RESULTS

The demonstration test plan has been developed. Discussions with Twin Cities Army Ammunition Plant (TCAAP) regarding the possibility of conducting a field demonstration on the installation shows high interest. TCAAP indicated the University of Minnesota (UMN) would be interested in participating in the demonstration. Crops selected for the process optimization study are appropriate for the Minnesota climate.

Other project progress includes:

- Phase 3 studies are in progress.
- Chelating Screening and Application studies to start in November 1996.
- Greenhouse cool season plant screening to begin in December 1996.
- Greenhouse warm season plant screening scheduled for January 1997.
- Greenhouse foliar application study for cool and warm season crops to begin April 1997.
- Soil leaching study for cool and warm season crops to begin May 1997.

LIMITATIONS

Use of phytoremediation of lead in soil may be limited by:

- Depth of contamination
- Degree of contamination
- Time constraints

RESOURCE SUPPORT

The U.S. Army Environmental Center has supported this project. Funding for a field demonstration is being sought through the Environmental Security Technology Certification Program.

POINT OF CONTACT

Darlene Bader

PROGRAM PARTNERS

U.S. Army Environmental Center

Tennessee Valley Authority

Plant Uptake and Compost Weathering Studies on Composted Explosives-Contaminated Soil

Composting explosives-contaminated soil has been demonstrated as a cost effective method for reducing explosives in the soil. Following composting, the soil is often returned to the site. Long term studies are needed to determine if the transformation products of explosives will weather, or if plants will extract these transformation products from the composted soil. These studies will provide the necessary information for environmental protection and compliance.

PURPOSE

To provide data from controlled greenhouse studies using both human consumable plants and range plants to answer concerns regarding plant uptake of explosives transformation products, and long term weathering studies.

BENEFITS

Establishing the weathering characteristics and the susceptibility for plant uptake of explosives transformation products will facilitate regulatory approval.

BACKGROUND

Composting has been developed as a cleanup technology for explosive-contaminated soil, however, the technology does not achieve complete explosive mineralization causing questions about its effectiveness. The TNT transformation products appear to be strongly bound to the compost material and are unextractable. This project will test the availability of TNT transformation products from composted soil for plant uptake or release in the soil by plant root exudates. Long term weathering studies will be conducted to determine the stability of compost over time when exposed to weathering.

Composting explosive-contaminated soil costs about 60% as much as incineration to cleanup contaminated sites. Numerous installations are considering composting as a cleanup technology. However, the question of TNT mineralization keeps the technology from being accepted without reservation by the academic community, the regulatory community, and the Corps of Engineers. Even though the transformation products are not extractable, there is concern that plants and long term exposure to weather may release these products.

DESCRIPTION

The project team consists of USAEC as the lead agency and the Tennessee Valley Authority (TVA) as the performer.

The project consists of four elements: shipping finished compost from Umatilla Army Depot Activity to TVA and producing control compost from soil and amendments from Umatilla at TVA, developing and testing analytical methods, conducting greenhouse studies, and conducting long term weathering studies. All testing is to be conducted at TVA's facility in Muscle Shoals, AL.

Composting was used at Umatilla to treat the explosive-contaminated soil from two lagoons. This composted soil will be shipped to TVA for testing. Amendments used at Umatilla and uncontaminated soil from Umatilla will be shipped to TVA to produce a control compost to be tested along with the contaminated soil compost.

Finished compost from Umatilla will be used in long term weathering studies to determine what happens to compost when exposed to sunlight, weather, and soil microbes. Different mixtures of compost and soil will be placed in large pans outside and exposed to the elements. Leachate will be collected and analyzed along with compost/soil samples over a three year period. The compost/soil mixtures will

not be manipulated in any manner during the weathering study

A total of nine plants will be tested with Umatilla compost and control compost. The vegetable crops to be tested include radish, kale, bush beans, tomatoes, and chives. The range crops to be tested include alfalfa, sorghum, red top, and winter barley. Roots, stems and leaves, fruit, and soil around the root ball will be tested.

Analytical methods exist for explosives in soil and water, but the suitability of these methods to detect transformation products in plant tissue extracts are not certain. Personnel from Cold Regions Research Engineering Laboratory (CRREL) and U.S. Army Waterways Experiment Station (USAWES) will assist chemists from USAEC and TVA to determine the efficiency of these methods.

Applicability

Andrulis Report Requirement:

- 1.3.a Explosive Soil

Accomplishments and Results

- The test plan and safety plan have been prepared and approved.
- The finished compost, compost amendments, and uncontaminated soil have been shipped from Umatilla to TVA.
- Chemists from TVA, WES, USAEC, and CRREL have been conducting research to identify the appropriate analytical methods.
- The weathering studies have been initiated and several leachate samples collected from rainfall on the pans.
- The control compost has been prepared.
- Lab/greenhouse testing has begun to establish the maturity of the control and Umatilla compost.

Resource Support

Funding is provided from the DERA Program.

Follow-On Program Requirements

- Initiate plant studies
- Complete plant studies
- Complete weathering studies
- Prepare Final Report

Point of Contact

Wayne Sisk

Remediation of Chemical Agent Contaminated Soils Using Peroxysulfate

Many locations have been used to bury or use chemical agents. Chemical agent contaminated soils must be cleaned to acceptable levels. Peroxysulfate has been shown to effectively degrade other similar organic materials and shows promise as a method to remediate soils contaminated with chemical agents.

PURPOSE

To demonstrate peroxysulfate's effectiveness for the treatment of soils contaminated with chemical agents.

BENEFITS

Adapting an existing technology to treat soils contaminated with chemical agents will provide an alternative treatment which has been proven.

BACKGROUND

There are 227 sites at 93 locations across the United States where non-stockpiled Chemical Warfare Materials (CWM) have been buried or discharged. The CWM that may be found could be present as mortar rounds, aerial bombs, rockets, projectiles, storage containers, or as discharged material in a drain field. Sites are still being identified where CWM are buried. There is also potential at some of the identified sites where CWM may have migrated into the groundwater. The DoD emphasis in chemical agent cleanup has been in stockpiled materials. A limited emphasis has been placed on these nonstockpiled materials. Cleanup technologies will need to address agent remediation as well as any degradation products that pose an environmental concern. It is unlikely that any in-situ technologies will be suitable because much of the CWM appears to be buried in containers of some form. TVA has extensive experience using peroxysulfate compounds in the remediation of soils contaminated with organics (PCBs and atrazine) and because peroxysulfate compounds have been investigated for surface decontamination of Chemical Warfare Agents (CWA), it seemed prudent to investigate their effectiveness on CWA contaminated soils.

DESCRIPTION

Peroxysulfate compounds are water soluble and do not require light or metal catalyzed activation. They react rapidly with CWAs, such as HD, GB, and VX and are more stable in soils than comparable oxidants, such as hydrogen peroxide. These characteristics make peroxysulfates ideal for soil remediation.

Phase I aqueous treatability studies have been completed for all CWA simulants. Phase II soil treatability studies with all CWA simulants have also been completed.

Phase I was to evaluate peroxysulfate reactions with agent simulants. Aqueous solutions of chemical warfare agent simulants, CEES, DIMP, and O-methyl-s-methylphenylphosphonothioate,were exposed to strong oxidants, peroxydisulfate and peroxymonosulfate. Reaction rates for simulant disappearance in solution were obtained by analyzing the reaction solution with gas chromatography, ion chromatography, and high pressure liquid chromatography. Reaction products and intermediates were detected, and confirmation that the simulants were completely mineralized (degraded to CO2, PO4, Cl, and SO4) were obtained. Reaction results between the simulants and peroxymonosulfate and peroxydisulfate were compared. The final product distributions, ability to mineralize the contaminants, and the effects of elevated temperatures were assessed. Comparisons between hydrolysis and peroxysulfate reaction rates were also made. This work was necessary in order to obtain enough background knowledge on CWA degradation by peroxysulfate compounds to be able to follow reactions in more complex matrices, such as soils.

In Phase II, soils were spiked with CEES, DIMP, and O-methyl-s-methylphenylphosphonothioate.The soils were slurried in an aqueous peroxysulfate solution, agitated, and sampled periodically. The soils were analyzed for the parent contaminant and any degradation products. Degradation rates were compared with hydrolysis rates. The reaction time and peroxsulfate dose level required for complete contaminant degradation were determined. Several soil types were investigated to ensure that the technology will be applicable at a variety of sites. Comparisons were made between peroxymonosulfate and peroxydisulfate. Information was gathered on the ability or inability of each oxidant to scavenging side reactions with soils. The information obtained in Phase II will be used to recommend whether scaling up the technology is reasonable.

APPLICABILITY

Andrulis Report Requirements:

- 1.3.b On-Site Treatment Processes for Organic Contaminated Soils
- 1.5.a Chemical Warfare Material

ACCOMPLISHMENTS AND RESULTS

Preliminary results with heated peroxdisulfate solutions show a capability for treating soils contaminated with all three CWA (VX, GB, and HD) simulants. TVA is currently performing a cost benefit analysis and preparing a conceptual design for a remediation unit.

POINT OF CONTACT

Louis Kanaras

PROGRAM PARTNERS

U.S. Army Environmental Center

Tennessee Valley Authority

Soil Slurry Biotreatment

Army industrial installations face high costs to cleanup soil contaminated by past explosives operations. Remediating these sites is a prerequisite for beneficial reuse by the Army and environmental protection. These installations require cost-effective techniques to treat large volumes of explosives-contaminated soils. The U.S. Army Environmental Center has tested soil slurry biotreatment (bioslurry) as an alternative to incineration.

PURPOSE

To prove that explosives-contaminated soil degradation in a soil slurry bioreactor is both possible on a large scale and an affordable alternative to incineration.

BENEFITS

Contaminated soil can be treated and returned to its original location.

TECHNOLOGY USERS

DoD installations containing areas of explosives-contaminated soils.

BACKGROUND

Past production and handling of conventional munitions has left explosives in soils at many Army installations. Depending on the concentrations of explosives - mainly trinitrotoluene (TNT), cyclonite (RDX), and cyclotetramethylene (HMX) - the affected soils can pose reactivity and toxicity hazards. Because these explosives can migrate from the soils into groundwater, the affected soils should be treated to eliminate any threat to human health or the environment.

Incineration is the traditional proven cleanup technology but it is costly and not readily accepted by regulators and the public. The Army has searched since the 1980s for alternatives to incineration. Extensive tests have shown that bioremediation - the use of living organisms to remove pollutants from soil or water - could be a cost-effective treatment. These microorganisms can digest a number of materials such as explosives, fuels, or solvents; this process is enhanced by providing the microorganisms favorable conditions. USAEC has field tested several bioremediation methods including windrow composting and soil slurry reactor biotreatment.

DESCRIPTION

In 1995, USAEC conducted a soil slurry bioremediation test at Joliet Army Ammunition Plant (JOAAP), Illinois with Argonne National Laboratory as the performer. Conditions were established to encourage microorganism growth and demand for the contaminants. Because the process maintains optimum conditions and the slurry is mixed to maintain contact between the microorganisms and the contaminants, slurry processes are faster than many other biological processes.

Bioslurry technology requires excavation and soil screening to remove oversize rocks and plant roots, mixing soil with water to form a slurry in a reactor, and removal of the slurry from the reactor. Explosives degradation also requires a co-substrate (e.g., molasses), pH between six and seven, and aerobic-anoxic operation. In this study, the native microbial population degraded explosives in soil. Four reactors (350-380 gallons) were operated at the JOAAP; a control with no co-substrate, 20% and 10% weekly replacement (by volume) reactors, and a 5% daily replacement reactor.

This design allowed investigation of different soil (and therefore TNT [2, 4, 6-trinitrotoluene]) loading rates. The target soil slurry was 15% (weight/weight). Explosives concentrations in soil were 2000 - 8000 mg/kg. Environmental conditions were identical for all reactors, and temperature, pH, and dissolved oxygen were similar.

USAEC examined the addition of a surfactant to reduce surface tension of the

slurry, allowing improved contact between the microorganisms and the explosive contaminants. This was shown to provide no significant improvement in treatment efficiency and is not recommended.

APPLICABILITY

Andrulis Report Requirements:

- 1.3.a Remediation of Explosives in Soil
- 1.3.b On-Site Treatment of Organics Contaminated Soils
- 1.3.c Explosives/Organics Contaminated Sediments
- 1.3.m Soil Bioremediation
- 2.3.d Develop Alternative Technologies to Mitigate Contaminated Soil

ACCOMPLISHMENTS AND RESULTS

The bioslurry system has a real potential to remove explosives, particularly TNT, from soil.

At JOAAP, Aerobic Bioslurry was used to reduce TNT, HMX, and RDX concentrations in soil. In this process, soil and water were mixed to create a slurry (the soil suspended in water maximizes microbial contact). The microorganisms are native to the contaminated soil. Molasses was added to spur microbial growth and activity. Metabolic fate studies of field samples showed up to 20% of the contaminant completely mineralized and given off as CO_2. Another 55% of the contaminant showed up as organic acids and carbon fragments in the biomass, indicating a high degree of breakdown of the contaminant

Other results included:

- Greater than 99% reduction of TNT, RDX, and HMX
- Aerobic/anoxic cycling enhances degradation (minimizes accumulation of metabolic intermediate byproducts
- Metabolic fate and high degree of breakdown
- Product suitable for land application
- Process water can be recycled
- Use of molasses as most effective and cost-effective co-metabolite or co-substrate
- Degradation activity slows below 20 ^{0}C
- The biological process is robust and can adapt to a variety of soil concentrations and temperatures. During normal operating conditions, soil loading can be increased to maximize throughput, and in cold weather, minimizing additions of contaminated soil will enhance system survival.

LIMITATIONS

- Oversized rocks and plant roots must be removed before bioslurry use
- Organic co-substrate needed
- pH greater than six to seven
- Cold temperatures slow microbial metabolism rate

POINT OF CONTACT

Mark Hampton / Wayne Sisk

PROGRAM PARTNERS

U.S. Army Environmental Center

Joliet Army Ammunition Plant, Illinois

Iowa Army Ammunition Plant, Iowa

Publications

Feasibility of Biodegrading TNT-Contaminated Soils in a Slurry Reactor, Technical Report CETHA-TE-CR-90062, U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, prepared by Argonne National Laboratory, Illinois, June 1990.

Feasibility of Biodegrading Explosives-Contaminated Soils and Groundwater at the Newport Army Ammunition Plant, Technical Report CETHA-TS-CR-92000, U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, prepared by Argonne National Laboratory, Illinois, June 1991.

A Laboratory Study in Support of the Pilot Demonstration of a Biological Soil Slurry Reactor, Technical Report SFIM-AEC-TS-CR-94038, U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, prepared by Argonne National Laboratory, Illinois, July 1995 (available in print and on CD-ROM).

Field Demonstration of Slurry Reactor Biotreatment of Explosives-Contaminated Soils; USAEC Report No. SFIM-AEC-ET-CR-96178; April 1997 (Available in print and on CD-ROM).

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Solar Detoxification of Soil

Many DoD installations require soil contamination remediation. Existing techniques for this decontamination may require large amounts of energy. Installations in regions which receive much sunlight may use solar energy for remediation. The heat of the sun can provide the temperatures necessary to destroy contaminants in soil.

PURPOSE

To evaluate solar energy for contaminants destruction removed from soil at DoD sites.

BENEFITS

A soil-remediation system using solar energy may cost less and work more effectively than conventional technologies used by the Army to destroy organic contaminants. The process is doubly attractive for soil remediation because it can destroy contaminants without increasing the demands on traditional energy sources.

TECHNOLOGY USERS

DoD sites containing soil contamination.

BACKGROUND

Excavation and off-site disposal of organic contaminated soils is very expensive. On-site incineration is hindered by lack of public acceptance. Destruction of organic contaminants by solar energy may be more cost effective than the other current methods and without the public relations problems of on-site incineration.

DESCRIPTION

There is a need for a less costly alternative to off-site disposal of contaminated soils or on-site incineration.

To develop a remediation system that uses solar energy to destroy organic contaminants desorbed from soil. The project is a collaboration among the EPA Risk Reduction Engineering Laboratory (RREL), the Department of Energy National Renewable Energy Laboratory (NREL), and the USAEC.

Operational costs comparable to existing remediation technologies. Destruction and Removal Efficiency of at least 99.9999% is improved performance over incineration.

The system addresses to the Cleanup pillar and applies to semivolatile, VOCs and POLs.

Decontamination of soils and groundwater often require heat to volatilize or destroy the contaminant. Solar energy is a heat source. This project is a congressional item to investigate, design, and build a solar system to destroy chemical contaminants.

The system can use vacuum extraction to remove the contaminants from soils. The contaminants can then be condensed and fed to a solar reactor. The contaminants will be destroyed by photochemical and thermal reactions.

APPLICABILITY

Andrulis Report Requirement:

- 1.3.b On-Site Treatment Processes for Organic Contaminated Soils

ACCOMPLISHMENTS AND

The USAEC and NREL have completed preliminary cost and performance feasibility studies. The RREL has constructed a "mini-pilot" system for laboratory

RESULTS

testing. Final design of a full-scale system has been completed.

LIMITATIONS

The system requires high levels of solar insulation.

FOLLOW-ON PROGRAM REQUIREMENTS

Performance data and cost assessment needs will be addressed during demonstration testing. Basic research and development must be performed by RREL if funding is available.

POINT OF CONTACT

Ronald Jackson

PROGRAM PARTNERS

USDOE National Renewable Energy Laboratory

USEPA Risk Reduction Engineering Laboratory

Science Applications International Corporation

PUBLICATIONS

Final Report Available Potential Feasibility of Using Solar Energy for Gas-Phase Destruction of Toxic Chemicals, USATHAMA Report CETHA-TS-CR-92049, Pacific Northwest Laboratory, July 1992.

Preliminary System Design for Solar Detoxification; Interim Report 1, USAEC Report ENAEC-TS-CR-93094, Science Applications International Corporation, March 1993.

Preliminary System Design for Solar Detoxification; Interim Report 2, USAEC Report ENAEC-TS-CR-93095, Science Applications International Corporation, March 1993.

Preliminary System Design for Solar Detoxification of Soils; Final Report, Task 1, USAEC Report ENAEC-TS-CR-93093, Science Applications International Corporation, June 1993.

SOLID WASTE

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Fuel Additive Unit

Maintenance of equipment stored for deployment often generates large quantities of waste as fuels and other fluids degrade and must be changed. Purifying these fluids provides a means to eliminate diesel fuel waste.

PURPOSE

To Fuel Additive Unit (FAU) is used to eliminate the need for expensive contaminated diesel fuel disposal through reclamation.

BENEFITS

The FAU has not been formally recognized though a formal requirement document. It has though been listed as fuel handling equipment requirement by the Army Quartermaster School. By developing a performance based purchase description, there will be incorporation of existing commercial and government standards of diesel fuel without mandating a specific design. This will allow installations to adapt the FAU to their specific environmental needs. The FAU will increase vehicle readiness, provide a tool for "the one fuel on the battle field concept", and save money though reduced fuel disposal costs and utilizing contaminated fuels. The FAU eliminates the need for expensive disposal of contaminated diesel fuel which is considered a hazardous waste.

TECHNOLOGY USERS

Primary target for future use has been Army installations and depots, as well as other DoD facilities.

BACKGROUND

The FAU is used to reclaim diesel fuel which is considered a hazardous waste. The nature of tactical vehicles forces them to experience long dormancy periods. During this period, diesel fuel tends to break down, creating free water and allowing for microbial buildup and deposits. These contaminants disrupt vehicle operation by plugging filters, increasing motor wear, and decreasing engine performance. The FAU provides a quick, efficient, and inexpensive means of removing these contaminants while injecting additives to prevent further fuel decomposition.

There have been numerous facilities that have utilized the FAU unit. The prototype unit has been used at Fort Stewart, Camp Pendleton, Twenty-Nine Palms, and Blount Island Marine Command. In addition, Blount Island was so impressed that they purchased their own FAU with numerous additions and upgrades.

DESCRIPTION

The FAU approach will be to aid the user community by developing a performance based purchase description. The performance based purchase description will be based on a market survey of fabricators and vendors for the FAU. This will be achieved by placing a notice in the Commerce Business Daily. There will be a field test plan created to assist the user in the application of the FAU and additive injections during field operations. Finally there will be a need to continue assisting in procurement, training, field support, and technology transfer to fulfill the user needs. The FAU provides a quick, efficient, and cheap means of removing these contaminants while injecting additives to prevent further decomposition of the fuel.

Applicability

Andrulis Report Requirement:

- 3.9.f Direct Reuse of Waste Oil

Accomplishments and Results

Blount Island Command could not be more enthusiastic about their FAU. They use the unit to clean every vehicle fuel cell coming off the prepositioned Marine ships after their 30-month cruise.

The Blount Island Command reports a payback period of less then one year on their FAU unit. Savings in diesel fuel disposal and replacement paid for the unit.

The FAU prototype has assisted numerous installations in dealing with their fuel contamination problem. The FAU is scheduled to assist Fort Knox during the summer of 1997 with USAEC's aid.

Limitations

The FAU is a collection of off the shelf technologies, therefore cost of the FAU varies. Also the purchase description will aid the user in design and contracting for the production of their own FAU.

The FAU is a collection of off-the-shelf technologies, therefore, FAU cost varies. The purchase description will aid the user in design and contracting for producing their own FAU.

Follow-On Program Requirements

Support for MDW will continue by preparing a procurement package for the FAU. The draft report of the performance purchase description will also be due during the first quarter.

There is an effort to create fact sheets for the FAU and the hydraulic fluid recycling. Blount Island Command is willing to give up some of their homepage space to explain the FAU. Information regarding these projects also will be added to the USAEC homepage.

Point of Contact

Dennis Teefy

Program Partners

U.S. Army Environmental Center

Fort Belvoir Fuels and Lubricants Technology Team, TACOM

Publications

Purchase Description is forthcoming.

Hydraulic Fluid Recycling

The Army uses large quantities of hydraulic fluid in the operation of various types of equipment. Installation commanders must pay high costs to dispose of used hydraulic fluid. By recycling hydraulic fluid to Army specifications, an installation will reduce waste quantity and disposal charges, allowing for more money to be spent on troop training.

PURPOSE

The current project focuses on the need to place in line sensors to determine the particulate and water content of the fluid being recycled.

BENEFITS

By installing the in-line sensor the machines will be more user friendly, cost-effective, and better able to meet the military needs by increasing automation of the system.

The ability to extend the life of Fire Resistant Hydraulic Fluid (FRH) will save money which could be used for increased troop training and readiness. Maintenance schedules would be easier to follow because procurement of FRH would decrease. The in-line monitoring of the recyclers will allow for a simple means of determining FRH batch cleanliness assuring the maintenance individual of the quality and readiness of the fluid.

TECHNOLOGY USERS

Primary targets for future use have been Army depots as well as other DOD facilities.

BACKGROUND

Hydraulic fluid is currently disposed of as a hazardous waste. The military uses large quantities of FRH in a variety of materials from bridge launchers to forklifts.

Hydraulic Fluid Recyclers have been field tested and the primary target for future use have been Army depots such as Anniston Army Depot.

DESCRIPTION

A field demonstration and analysis studying the feasibility of recycling hydraulic fluid shows that when mixed with 25% virgin material, the recycled fluid meets all specification performance requirements. Lessons learned from that demonstration showed that there is a need for real-time fluid analysis. The current project focuses on the need to place in-line sensors to determine the particulate and water content of the fluid being recycled. By installing the in-line sensor, the machines will be more user friendly, cost effective, and better able to meet the military needs by increasing automation of the system.

The FRH recycling utilizes past research in the viability and field demonstration of commercially available recycling units. There will be analysis to determine which units produce FRH which meet military specifications. Cooperative Research and Development Agreements (CRADAs) have been installed to leverage government and private efforts to improve the design of the recyclers while increasing user friendliness. The monitors will be tested for accuracy and compared to conventional laboratory analysis.

The in-line monitoring of the recyclers will determine FRH batch readiness, assuring the quality and readiness of the fluid.

APPLICABILITY

Andrulis Report Requirement:

- 3.9.f Direct Reuse of Waste Oil

ACCOMPLISHMENTS AND RESULTS

CRADAs have been signed with two companies interested in adding in-line sensors to their hydraulic fluid recyclers. Pall Aerospace and Sesco Inc. have begun work on fitting their existing machines with monitors and to test their accuracy. Testing and development are scheduled to continue.

Current purchase price for new FRH is roughly $10/gallon. The cost of reclaiming the fluid is calculated at less than $0.20/gallon. The procurement needs of new fluid would be reduced 75%. It is estimated that Anniston Army Depot, which uses 10,000 gallons of FRH fluid per year would recoup the cost of their initial investment in their first year of reclamation.

The Military District of Washington (MDW) and other Army environmental user community representatives have expressed the need for evaluating existing commercial systems capable of reducing waste streams produced from used hydraulic fluid and contaminated motor fuel. Environmental Technology Division (ETD) is sponsoring this work through the U.S. Army TACOM Mobility Technology Center-Belvoir and recently completed negotiation of a project order and statement of work.

LIMITATIONS

Hydraulic fluid recycling is an excellent means to reduce costs and increase readiness. Users of this technology must be aware that hydraulic fluid recycling will require improved cleanliness, organization, and used fluids separation. A commitment of good housekeeping must be made.

FOLLOW-ON PROGRAM REQUIREMENTS

During the third quarter of FY97, the hydraulic fluid recycling draft and final report of the monitoring unit test will be submitted.

The FRH recycling utilizes past research in the viability and field demonstration of commercially available recycling units. There will be analysis to determine which units produce FRH which meets military specifications. CRADAs will be established to leverage government and private efforts to improve the design of the recyclers while increasing user friendliness. The monitors will be tested for accuracy and compared to conventional laboratory analysis.

POINT OF CONTACT

Dennis Teefy/Edward Engbert

PROGRAM PARTNERS

U.S. Army Environmental Center

Fort Belvoir Fuels and Lubricants Technology Team, TACOM

SESCO Inc.

PALL Aerospace

PUBLICATIONS

MIL-H-46170 Hydraulic Fluid Recycling: Field Demonstration, Ellen M. Purdy, Ralph B. Mowery, Sgt. Donna M. Rutkowski, October 1996, TR-13731

Plasma Arc Technology Evaluation

> Hazardous wastes disposal is a problem which is increasing in scope and cost. Because liability may remain for years following disposal, the costs are often high. These costs directly impact ongoing operations as many disposal charges are paid from operations funds. Plasma Arc Technology may provide a viable, permanent alternative without long-term liability.

PURPOSE

To evaluate the process capability of Plasma Arc Technology (PAT) for the ultimate destruction of hazardous item components; to verify slag suitability for regular landfill disposal; to identify potential hazards associated with the process emissions; and to develop qualified cost estimates for large-scale operations.

BENEFITS

The technology lends itself to "hard to treat" wastes such as hazardous wastes candidates which would have to be disposed of in a hazardous waste landfill. By virtue of a waste containing one or more hazardous substances even after treatment by more conventional methods (i.e., open burning of pyrotechnic wastes that would fail the TCLP test due to the high barium, lead, or chromium content), or military munitions for which there are no documented demilitarization procedures or those military munitions which will result in generating of hazardous wastes upon demilitarization or attempts at demilitarization (i.e., thermal batteries used in various missiles which contain the TCLP metals lead, silver, cadmium, barium, and chromium, as well as nickel and lithium, which are all toxic and/or carcinogenic and as a result of this combination of ingredients, no suitable disassembly/demilitarization has been worked out). For extremely toxic wastes such as chemical agents and chemical agent contaminated materials or radioactive waste for where handling should be minimized, PAT may be the necessary treatment process. Or hazardous waste candidates that allow PAT to be cost effective due to extensive characterization requirements both before and after processing, need for segregation or pre-treatment requirements, need for post-treatment being required for conventional treatment technologies, or need for treatment trains to treat hazardous waste with both inorganic and organic chemicals of concern.

PAT can be applied to the following types of candidate waste streams: waste paints, solvents, oily debris, labpacks of chemicals, sludge with metals, sandblast grit with lead (grit and/or paint chips), still bottoms with solvents and metals, paint debris, wastes from maintenance (oil, solvent, metals), used oil with solvents and metals, low-level radioactive wastes with solvents, oils, and solid consumables, chemical agent contaminated materials, incineration ash failing TCLP due to heavy metals, and other problematic wastes.

TECHNOLOGY USERS

All DoD facilities containing “hard to treat” wastes.

BACKGROUND

The U.S. Army has a continuing need for better disposal methods for environmentally hazardous and complex military wastes. Substances of particular concern to the Army include organics, inorganics, heavy metals, mixtures of organics and inorganics, chemical agents and chemical agent contaminated materials, medical wastes, and asbestos, which are toxic, carcinogenic, or both.

With the PAT application to hazardous wastes destruction gaining great advances world-wide, a feasibility study by the USACERL addressed asbestos vitrification (glassification) through PAT that it co-developed with the Georgia Institute of Technology through the U.S. Army Corps of Engineers Construction Productivity

Advancement Research (CPAR) program. In 1992, a joint study was conducted by the Armament Research Development and Engineering Center (ARDEC) and USACERL to investigate the feasibility of using plasma arc pyrolysis to destroy and permanently render inert armament-related hazardous waste.

Chemical manufacturers have used PAT for more than 30 years. NASA used it in the 1960s to simulate re-entry conditions during spacecraft development. The metallurgical industries later used PAT to prepare high-purity metals and to manufacture aluminum and steel.

DESCRIPTION

Concurrent Technologies Corporation (CTC), the operating contractor for the NDCEE, was tasked by USAEC to select candidate waste materials for Phase I Testing that can be treated by PAT.

Phase I wastes selected were an open burning ground soil from Picatinny Arsenal containing heavy metals and energetics, a Longhorn Army Ammunition Plant sludge containing heavy metals, Leterkenny Army Depot spent blast media (glass/plastic composite and walnut shell), and medical incineration ash from Medical Research Institute for Chemical Defense (Aberdeen Proving Ground) spiked at Retech with chemicals frequently found in hospital wastes.

Task 2 entails identifying a subcontractor who is able to treat the candidate waste materials in a suitable plasma waste system, based upon criteria specified in the Statement of Work. The PAT system should be able to destroy the selected waste materials.

Task 3 involves conducting and monitoring Phase I and Phase II testing, performed in accordance with a government-approved test plan and a quality assurance/quality control (QA/QC) plan. The slag should not be leachable, and the emissions should comply with the federal Clean Air Act. Outreach materials will be prepared to promote PAT and will include a video, a descriptive brochure, a technical applications and analysis report, and information entered into the Environmental Information Network (NDCEE) and the Defense Environmental Network and Information Exchange (DENIX). A cost estimate and procurement and design-fabrication guidance also will be prepared.

PAT applies to the following waste types:

- Concentrated liquid organic hazardous wastes. These wastes, including polychlorinated biphenyls (PCBs), paint solvents, and cleaning agents, are the most expensive to destroy. Chlorinated solvents and chlorofluorocarbons (CFCs) processes are in development. PAT is not affected by halogen concentrations.
- Low-level radioactive or mixed wastes. Plasma treatment offers the potential for the highest volume reduction and the formation of vitrified slags with the highest melting points. Its major advantage is requiring fewer steps to form the immobilized slag, because the same technology works for compaction and vitrification.
- Municipal solid wastes. These wastes, currently incinerated, contain combustible materials and could be hazardous because of metal content. PAT may be used to vitrify the ashes from the incinerator to eliminate hazardous materials.
- Medical wastes. Similar to municipal wastes, medical wastes have higher moisture content. PAT applies to these wastes if they contain metallic contaminants and if transfer to an incinerator is too expensive.
- Solid wastes contaminated with organic hazardous materials. These wastes include contaminated soils and containers filled with hazardous liquids (PCBs,

chemicals, warfare agents). Plasma arc will destroy the organic toxins, vitrify the solid materials to an unleachable compact state, and remove contaminants such as HCl and volatilized metals.

- Concentrated wastes resulting from soil-washing operations.
- Wastes from manufacturing processes. This type of hazardous waste contains metal such as chromium, cadmium, and zinc as metallic dusts from metallurgical processes (e.g., electric arc furnace dust). This PAT application is attractive because recovery of a raw material makes the process more economical. For example, iron, zinc, and aluminum all can be recovered.
- Hazardous waste candidates from various installations for which no acceptable waste disposal options exist because of cost factors, residual wastes after treatment with conventional technologies, incompatibility with waste treatment systems, or other legitimate reasons (i.e., permitting issues) that would preclude conventional treatment options.

APPLICABILITY

Andrulis Report Requirements:

- 1.3.a Remediation of Explosives in Soil
- 1.3.e Soil Inorganic
- 1.4.c Heavy Metals
- 1.4.b Pesticides & PCBs
- 1.4.d Lead Contamination
- 1.4.g Asbestos Contaminated Facilities

ACCOMPLISHMENTS AND RESULTS

Retech Inc., was selected as the vendor to supply PAT equipment and perform the demonstration at its facility. Retech's equipment, Plasma Arc Centrifugal Treatment (PACT 1.5-foot diameter) was used in the USACERL/ARDEC work and a PACT 6 unit was used in Butte, Montana, to destroy hazardous wastes of interest to the DOE and pyrotechnic-related wastes for ARDEC.

For this demonstration, Retech built a PACT 2 (2-foot diameter) that can process up to 100 pounds per hour, approximately four times that of the PACT 1.5. It should help determine reasonable process costs for larger systems while still determining mass balances, an integral part of this demonstration. Although Retech could collect valuable information on validating destruction of various waste streams in the PACT 6 system, it could not determine mass balances. Phase I testing was completed with successful Destruction and Removal Efficiencies (DREs) and non-leachable slags achieved in all test trials. The air quality met California standards except in the case of silver. Changes in the system will provide acceptable silver emission levels during Phase II testing.

Phase II hazardous waste materials evaluated included waste paint from U.S. Naval Base at Norfolk, Virginia, garnet blast media from McClellan Air Force Base, California, simulated oil-contaminated sorbent used by the Tri-Services and Private Industry, and soil spiked with dichlorobenzene (which was rated as a much more difficult compound to incinerate than chemical agents). Phase II testing has been completed, test data has been received from the lab, and a draft technical report has been submitted. CTC submitted a video depicting system operation of the PAT to USAEC.

Four candidates were selected for the initial feasibility tests: thermal batteries, metal-contaminated soil, incineration ash, and reject pyrotechnic smoke assemblies. All of these waste were successfully treated PACT 1.5 at the Retech facility. The technical objective of this project is to conduct a field scale

demonstration of the plasma arc technology.

LIMITATIONS

This technology costs more than many conventional technologies and should find its niche in the "hard-to-treat" wastes.

FOLLOW-ON PROGRAM REQUIREMENTS

- Final Technical Report to USAEC
- Final Video to USAEC
- Final Procurement/Design Fabrication Guidance to USAEC

POINT OF CONTACT

Louis Kanaras

PROGRAM PARTNERS

U.S. Army Environmental Center

Retech Inc.

U.S. Army Construction Engineering Research Laboratories

Georgia Institute of Technology

Armament Research Development and Engineering Center

Concurrent Technologies Corporation

National Defense Center for Environmental Excellence

PUBLICATIONS

Retech Inc., Plasma Centrifugal Furnace, Application Analysis Report, EPA/540/A5-91/007, Risk Reduction Laboratory, Office of Research and Development, EPA, June 1992.

Vitrification of Ash from a Municipal Solid Waste Incinerator (MSW) for the City of Bordeaux, France, Dr. Louis Circeo, Construction Research Center of Georgia Institute of Technology, October 1993.

Plasma Arc Vitrification, Richard C. Eschenbach, Retech Inc. (Presented at the EPA Fourth Forum on Innovative Hazardous Wastes Treatment Technologies: Domestic and International, San Francisco, Calif., November 1992).

Reuse of Waste Energetics as Supplemental Fuels

Munitions production and demilitarization generates large waste energetics quantities which require disposal. Past disposal practices could have regulatory or financial impacts. Incorporating waste energetics in fuels for installation boilers may reclaim the energy and reduce the disposal costs.

PURPOSE

To develop a technology for reusing waste energetics as a fuel oil supplement in industrial boilers.

BENEFITS

Supplemental fuels technology future implementation could be a cost-effective alternative to incinerating waste energetic materials and could become an alternative to (Open Burning / Open Detonation) OB/OD which soon may not be an option due to environmental concerns associated with the process. Potential safety hazards may also be mitigated as the large stockpile of these obsolete munitions, scrap and off-specification materials can be utilized for a beneficial end use instead of being stored indefinitely.

TECHNOLOGY USERS

Many DoD facilities using industrial boilers. This effort should transition to any installation involved in the manufacture of explosives and propellants, installations involved in munitions demilitarization, rocket motors, etc. which contain explosives and/or propellants, and depots containing obsolete or off-specification explosives or propellants.

BACKGROUND

Waste energetic materials (propellants, explosives, and pyrotechnics) are generated in significant quantities by the U.S. Army due to the generation of off-specification materials during production and also in the demilitarization of obsolete munitions filled with these energetic materials. The Army, as the sole DoD manager for explosives, is evaluating and developing safe, environmentally acceptable, alternative disposal and reuse technologies for its waste energetic materials stockpile. These materials - propellants, explosives, and pyrotechnics - are commonly called PEP. Unserviceable materials remain from PEP manufacturing, munitions assembly, and the demilitarization of obsolete conventional munitions. About 2.5 million pounds of scrap energetic materials are generated each year. Moreover, about 200,000 tons of conventional munitions required demilitarization in 1990.

USAEC began investigating the feasibility of reusing energy from waste energetic materials to produce steam and electricity in 1984. Because explosives are a major waste energetic material in the Army's inventory, USAEC began investigating potentially using TNT, RDX, and Composition B (60% RDX, 40% TNT) as a supplemental fuel.

The disposal alternatives for these unserviceable PEP materials are open burning/open detonation (OB/OD) and incineration. OB/OD is the preferred method, but its use requires a Subpart X permit under RCRA. Because of environmental concerns, OB/OD is approved case-by-case. Incineration of energetic materials is uneconomical. To burn safely, energetic materials are mixed with about 75% water to form an energetic/material water slurry. The process requires water, which dramatically increases fuel costs, to prevent detonation propagation during the handling and feed process. Although OB/OD and incineration are acceptable disposal technologies, neither takes advantage of the material's energy content.

DESCRIPTION

Roy F. Weston Inc., involved in the design of the pilot-scale boiler and pilot-scale testing at Hawthorne Army Ammunition Plant, was awarded a task order contract to assist Indian Head Division, Naval Surface Warfare Center (IHDIV, NSWC) in:

- Identifying data gaps from previous laboratory and bench-scale testing on explosives and propellants supplemental fuels testing, and recommending testing to optimize implementing the technology
- Identifying nitrous oxide abatement technologies that can be incorporated on a typical full-scale boiler system (at an Army installation) to ensure compliance with new Clean Air Act regulations
- Identifying slurry nozzles suitable for firing wet-ground explosives and propellant/fuel oil slurries
- Providing operational and maintenance support during the pilot-scale demonstration on both explosives and propellants

Research has demonstrated successful disposal of waste-solvated explosives in the laboratory (1985), bench-scale studies (1988), and pilot-scale tests at Los Alamos (1989) and Hawthorne (1991). The boiler used in the pilot-scale test at Hawthorne, was a Cleaver-Brooks Model M4000, two million BTU water-tube boiler, one-tenth the size of most boilers at Army facilities. The prototype explosives dissolving and blending system were proven during the demonstration, and the technology demonstrated potential as an effective method to recover energy from waste explosives. Diluted TNT solutions (1%) safely and effectively blended with fuel oil and cofired, achieved a 99.99% destruction and removal efficiency (DRE).

The primary operational and safety problems resulted from the inability to keep TNT in the solution during testing at low temperatures. Nitrous Oxides (NO_x) emissions increased significantly when cofiring even a 1% TNT/No. 2 fuel-oil solution.

APPLICABILITY

- 2.C.1.b Solid-PEP-Demil/Disposal
- 2.A.1.a Air-Combustion-Products-General

ACCOMPLISHMENTS AND RESULTS

Weston has submitted final reports on (NO_x) abatement technologies, recommended slurry nozzles, and submitted a draft report on data gaps and recommended testing. Weston also has arranged for a subcontractor to perform necessary solubility and viscosity studies to fill in the data gaps identified in the study.

IHDIV, NSWC has been preparing the boiler and is having it certified for the demonstration which was anticipated to start in November 1995. The boiler internals were plugged with scale and needed to be replaced in 1995. New agitators, which were deemed necessary by IHDIV, NSWC personnel due to insufficient mixing of original agitators, were installed in 1995. A lab particle size mixing study was conducted by IHDIV, NSWC personnel in 1995. Atomizers, a mass flow meter, and a solvent meter were installed in 1995 respectively. An Inert demonstration on the system was conducted in 1996. An in-situ particle size analyzer was installed in 1996. A Technical Review on the Supplemental Fuels System was conducted in 1996. A surfactant study, melting process study, and a grinding study were conducted by IHDIV, NSWC personnel in 1996. The Continuous Emissions Monitor (CEM) installation took place in 1996 with certification in 1996.

LIMITATIONS

Mature slurry nozzles with recirculation capabilities must be used. Another limitation is identifying of ideal solvents for their solubility and viscosity, economics, and health effects, should solvation prove to be the preferred approach for firing explosives-supplemented fuels.

RESOURCE SUPPORT

SERDP provided support for this project.

FOLLOW-ON PROGRAM REQUIREMENTS

The pilot-scale equipment has moved to IHDIV, NSWC, Indian Head, Maryland., where the Navy and the Army, as a result of a 1994 Memorandum of Agreement, will develop the technology together.

Recommended modifications to the supplemental fuels system, as a result of the pilot-scale test at Hawthorne, are incorporated into the equipment design. Initial testing at IHDIV, NSWC with use TNT-supplemented fuel (1%, 10 %, 15 %) and Comp B-supplemented fuel (1%, 4 %, 8 %) at various excess air percentages

Follow-up testing will investigate supplementing fuel with nitrocellulose (NC), nitroguanidine (NQ), AA2 double-based propellant, and Otto Fuel. The propellants with be wet-ground and mixed with fuel oil and will be fired through a slurry nozzle into the burner. Comparisons between solvation and wet-grinding will determine the preferred approach for firing the explosives-supplemented fuels. A final report with be prepared at the conclusion of the testing as well as an operations manual and a video depicting system operation. Equipment modifications will be made and "as modified drawings" will be prepared, if necessary. A cost analysis will then be performed and a procurement/fabrication package will be prepared.

TNT Test

Comp B Test

Technical Report on Explosives

Otto Fuel Test

Nitroguanidine Test

Identify Full Scale Demo Location

Nitrocellulose Test

Technical Report on Propellants

The Supplemental Fuels System Baseline Test to depict off-gas emission of burning fuel oil only is scheduled to take place in 1997.

POINT OF CONTACT

Louis Kanaras

PROGRAM PARTNERS

The U.S. Army Environmental Center

Roy F. Weston Inc.

Indian Head Division, Naval Surface Warfare Center

PUBLICATIONS

Technical report, Testing to Determine Chemical Stability, Handling Characteristics, and Reactivity of Energetic-Fuel Mixtures, USATHAMA Report AMXTH-TE-CR-87132, April 1988.

Technical report, Pilot-scale Testing of a Fuel Oil-Explosives Cofiring Process for Recovering Energy from Waste Explosives, USATHAMA Report AMXTH-TE-CR-88272, May 1988.

Technical report, Phase I: Pilot Test to Determine the Feasibility of Using Explosives as Supplemental Fuel at Hawthorne Army Ammunition Plant (HWAAP) Hawthorne, Nev., USATHAMA Report CETHA-TE-CR-91006, April 1991.

Technical report, Laboratory Tests to Determine the Chemical and Physical Characteristics of Propellant-Solvent-FuelOil Mixtures, USATHAMA Report CETHA-TE-CR-90043, April 1990.

Technical report, Technical and Economic Analyses to Assess the Feasibility of Using Propellant-No. 2 Fuel Oil Slurries as Supplemental Fuels, USATHAMA Report CETHA-TE-CR-91046, September 1991.

Technical report, Zero-Gap Testing of Propellant-No. 2 Fuel Oil Slurries, USATHAMA Report, CETHA-TS-CR-92005, January 1992.

Transportable Hot Gas Decontamination

Facilities contaminated with explosives or chemicals often require destructive or expensive cleanup. Destructive cleanup may prevent some equipment from being reused, allowing sale as scrap or burial. Hot Gas Decontamination provides more effective decontamination than other methods and does not destroy the material being cleaned.

PURPOSE

To conduct a transportable hot gas decontamination system field demonstration which can be used to decontaminate explosive/propellant contaminated underground piping and sewer lines that have been excavated.

BENEFITS

This technology will offer a cost efficient alternative to open burning/open detonation which is the current method of decontaminating underground piping. Hot gas decontamination technology generates controlled "regulatory acceptable" emissions, reduces personnel hazards, allows a quality control/quality assurance program, and will allow for some reuse of the decontaminated material while allowing the non-reusable material to be discarded as scrap material.

This technology may also have utility for decontaminating process equipment or scrap materials contaminated with chemical agents, based upon past investigations, or other hazardous wastes which might be encountered in a remediation effort which possess small internal diameters or hard to reach areas which preclude steam cleaning. Using hot gas technology also eliminates contaminated process water associated with steam cleaning operations.

TECHNOLOGY USERS

Sites where DoD installation restoration or base closure activities have left an abundance of energetics-contaminated piping or sewer lines, process equipment, or other energetics-contaminated debris of suitable size, and installations also interested in potential transfer of the transportable hot gas decontamination for treatability studies and cleanup activities.

BACKGROUND

Hot Gas Decontamination can be used to decontaminate explosive/propellant contaminated underground piping and sewer lines that have been excavated. This technology is also applicable for other energetic contaminated items which can fit into the internal working diameter of the hot gas decontamination chamber (10' length x 6' height x 4.5' width) such as mines and shells being demilitarized or other process equipment or scrap materials contaminated with energetics.

DESCRIPTION

This technology applies to any piping or process equipment of suitable size with internal surfaces or parts that are hard to decontaminate with physical methods or with contaminated surfaces that retain contamination even after surface decontamination.

Identifying sites where installation restoration or base closure activities have left an abundance of energetics-contaminated piping or sewer lines, process equipment, or other energetics-contaminated debris of suitable size, and installations also interested in potential transfer of the transportable hot gas decontamination for treatability studies and cleanup activities.

This advanced technology effort builds upon a 1990 demonstration on larger equipment at Hawthorne Army Ammunition Plant (HWAAP), Nevada., where the technology proved feasible for remediating explosives-contaminated sewer pipes

and process equipment.

Applicability

Andrulis Report Requirements:

- 1.4.h Nondestructive Decontamination of Facilities
- 1.4.e Recycling/Disposal Options for Building Materials

Accomplishments and Results

The contractor, Roy F. Weston, identified furnace and afterburner manufacturers to design and detail transportable hot gas decontamination components to system specifications. Weston also shop-tested and shipped components to Alabama Army Ammunition Plant (ALAAP), the site selected for the field demonstration. The firm developed safety and test plans and site-specific engineering. Weston installed the plant and received approval from the Alabama Department of Environmental Management on the Treatability Study Test Plan.

The hot gas process was found to be effective for treating items contaminated with TNT, RDX, and tetryl. A 5X decontamination level is achieved at operating conditions of 600 ^{0}F (steady state) for one hour. No detectable levels of explosives were observed in the stack emission during the stack testing program. The hot-gas process can meet mandated air quality emissions requirements, thus making the hot gas process available for implementation as a viable 5X decontamination technology.

Deliverables included: Final Technical Report, Final Video, Technical Brochures, Application and Analysis Reports, Cost and Performance Reports, Operations and Maintenance Manuals, and Procurement & Fabrication Analysis Reports.

Following the demonstration program at ALAAP, the transportable hot gas decontamination unit was shipped to TVA and modified by TVA to remove the flame from inside the hot gas decontamination chamber. TVA also has purchased a dedicated CEM system which is now part of the hot gas decontamination system.

Limitations

Components must be able to fit into the transportable hot gas decontamination furnace (4.5' wide, 6' high, and 10' long). This system can be configured however for decontamination of much larger components, with an air blower and appropriate ducting. The larger contaminated components, once vital as the hot gas chamber with contaminated vapors is being ducted to the thermal oxidizer.

Resource Support

The follow on effort is being funded by the Industrial Operations Command.

Follow-On Program Requirements

Industrial Operations Command (IOC), Rock Island, has funded cleanup effort at Newport Chemical Depot (NECD) in Newport, Indiana with this transportable hot gas decontamination unit to dismantle the NECD TNT plant's piping and equipment and dispose of it by selling as surplus property. This effort is scheduled to take place between 1996 to 1998.

Point of Contact

Louis Kanaras

Program Partners

U.S. Army Environmental Center

Alabama Army Ammunition Plant

Roy F. Weston

Tennessee Valley Authority

PUBLICATIONS

Identification and Evaluation of Novel Decontamination Concepts, USATHAMA report DRXTH-TE-CR-83211, 7/83.

Technical report, Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Laboratory. Evaluation of Novel Explosives Decontamination Concepts, USATHAMA Report AMXTHE-TE-TR-85009, 3/85.

Technical report, Design Support for a Hot Gas Decontamination System for Explosives-Contaminated Buildings, Maumee Research & Engineering, 4/86.

Technical report, Pilot Plant Testing of Caustic Spray/Hot Gas Building - Decontamination Process, USATHAMA Report AMXTH-TE-CR-87112, 8/87.

Technical report, Task Order 2, Pilot Test of Hot Gas Decontamination of Explosives-Contaminated Equipment at HWAAP Hawthorne, Nevada, USATHAMA Report CETHA-TE-CR-9003, 6/90.

Technical report, Hot Gas Decontamination of Explosives-Contaminated Items, Process and Facility Conceptual Design, USAEC Report SFIM-AEC-ET-CR-94118, 1/95.

Technical report, Field Demonstration of the Hot Gas Decontamination System, USAEC Report SFIM-AEC-ET-CR-95011, 2/95.

Technical report, Demonstration Results of Hot Gas Decontamination for Explosives at Hawthorne Army Depot, USAEC Report SFIM-AEC-ET-CR-95031, 9/95.

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Environmentally Redesigned Small Arms Ranges Demonstration

Many small arms ranges on DoD installations have soils that contain lead as a result of testing and training activities. Effective design of range areas and impact berms will minimize the potential for migration off site and will minimize maintenance requirements. As a result, these ranges will experience lower maintenance costs, greater availability for training, and improved environmental protection.

Purpose

To install at Fort Rucker's South Range, several different soil fixation technologies and civil engineering improvements which will serve as a test bed for improving current and future Army small arms ranges.

Benefits

To prevent future degradation and migration, new technologies are needed to minimize soil erosion, lead-smearing, and allow for easier range maintenance. The five technologies cells along with reconfigured berm designs in this demonstration will attempt to prevent rainwater infiltration and leaching of the lead to surface runoff and into the surrounding environment.

Technology Users

All soldiers and range personnel.

Background

Numerous Army installations operate firing ranges for small arms training to maintain military troop readiness. At many of these ranges impact berms are often used as back-stops and bullet trapping devices. Typically these berms are engineered piles of soil or modified hillsides. The projectiles which accumulate in these berms contain lead, a toxic heavy metal. The Department of Defense is undertaking a series of proactive initiatives to prevent adverse environmental impacts from small arms firing ranges. Many of these ranges have been in use since the onset of World War II and have accumulated large amounts of lead and other toxic heavy metals in the soil. These heavy metals have the potential to migrate off the ranges into the surrounding environment.

Description

The project, which began in September 1995 and will be completed in April 1997, consists of several phases, including planning, procurement and construction, live firing, and final documentation.

Accomplishments and Results

The results shown in this paper are preliminary:

- Future berm vegetation efforts should focus on the use of vine crops, legumes, and deep rooted drought resistant plants.
- Deep root structures stabilize the slope better than grass.
- Addition of top soil amendments including phosphate, carbon, and nitrogen will promote stronger root growth.
- Particulate transport of Pb away from the berm and into the detention basin occurs on the range. Alternatively, the sampling down stream of the detention basin, in the same spot, indicates that particulate Pb no longer moves significantly off site: May 1995 - 666 ppm, Oct 1996 - 22 ppm, and Dec 1996 - 2 ppm.

Follow-On Program Requirements

To be determined.

Point of Contact

Tony R. Perry

Program Partners

U.S. Army Environmental Center

Army Training Support Center

Huntsville Engineer District

Defense Evaluation Support Activity (DESA),

Fort Rucker

TRW, Inc.

Publications

Four page preliminary article authored by Mr. Tony R. Perry. Final documentation due in April 1997.

Fort McPherson Impact Berm Redesign and Construction

Many small arms ranges on DoD installations have soils that contain lead as a result of testing and training activities. Effective design of range areas and impact berms will minimize the potential for migration off site and will minimize maintenance requirements. As a result, these ranges will experience lower maintenance costs, greater availability for training, and improved environmental protection.

PURPOSE

To design and construct a berm at Fort McPherson's Pistol Qualification Range which will minimize the environmental impacts of erosion, minimize maintenance requirements and insure compliance with all environmental laws and regulations.

BENEFITS

Implementing new berm technologies at Fort McPherson will minimize maintenance requirements and facilitate compliance with RCRA, CERCLA, and the Clean Water Act.

TECHNOLOGY USERS

All DoD installations with small arms ranges.

BACKGROUND

Numerous DoD sites are at risk of heavy metal contamination due to extensive training use of small arms ranges. Numerous facility closures have occurred due to lead build-up in the soil, a RCRA listed toxic material. To prevent such closures and minimize impact on the Army training and readiness mission, new technologies are being developed and implemented.

Conventional small arms ranges become contaminated during normal operation by the heavy metals in the bullets. Environmental engineering techniques are necessary to minimize contaminant migration within and away from the range facility. At active sites such as Fort McPherson's 50-meter pistol range, these techniques will prevent pollution and allow for the continued operation of the facility.

DESCRIPTION

The Fort McPherson range will be designed to reduce erosion, storm water runoff, and the potential for vertical and lateral migration of heavy metals. A Project Order has been issued to U.S. Army Construction Engineering Research Laboratories (USACERL) to perform all work necessary to design and construct the impact berm at the Fort McPherson Pistol Qualification Range.

Numerous technologies will be examined and implemented at the Fort McPherson pistol qualification range. The U.S. Army Environmental Center (USAEC) will design the impact area/rang to reduce the potential for environmental risk and minimize maintenance requirements. Data from techniques implemented in the Fort Rucker Berm Redesign project will be leveraged to facilitate this effort. The project site will be evaluated to characterize the soil and identify heavy metals contained in the soil. USAEC will provide for implementation of the approved design at Fort McPherson in FY 97. At the conclusion of the effort, the site will be used in evaluating the implemented technologies.

Several approaches will be pursued followed by detailed recommended designs for construction. These approaches are outlined below:

- The redesign of an environmentally and structurally sound berm. The following measures may be necessary:
  - Addition of soil amendments to achieve optimum engineering potential

(i.e. maximum soil adhesion properties).

- Compact soil to optimum moisture and maximum density and implement a gabian retaining wall to enable a stable, low maintenance 45° slope in the lower impact area.
- The redesigned berm will include a mid-slope channel which will produce drainage and reduce runoff volume and energy. The specially constructed channel will extend laterally across the berm and distribute rainwater away from the slope face.

- The upper slope behind the retaining wall may be further stabilized by establishing a hearty vegetative cover. The vegetation will be selected based on soil and climatological data.

APPLICABILITY

Andrulis Report Requirements:

- 1.3.e Soil Inorganic
- 1.4.c Heavy Metal

ACCOMPLISHMENTS AND RESULTS

- The project order was accepted by the USACERL in FY96
- Design coordination between USAEC, USACERL, Ft. McPherson, Army Training Support Center (ATSC), U.S. Army Engineering and Support Center, Huntsville
- The construction effort will be performed by a specified subcontractor under USACERL

RESOURCE SUPPORT

Funding provided by Fort McPherson and USAEC.

FOLLOW-ON PROGRAM REQUIREMENTS

At the conclusion of the effort, the site will be used in evaluation of the implemented technologies.

POINT OF CONTACT

Lisa Miller

PROGRAM PARTNERS

U.S. Army Environmental Center

Fort McPherson, Georgia

U.S. Army Construction Engineering Research Laboratories

U.S Army Training Support Center

U.S. Army Engineering and Support Center, Huntsville

Green Ammunition

Millions of rounds of small arms rounds are fired annually on military ranges due to training and testing activities. Lead contained in these projectiles is a RCRA listed toxic material and may pose an environmental risk to soil, sediments, surface and groundwater. Replacing conventional lead in the projectile with a non-toxic tungsten core will minimize environmental compliance impacts on training and avoid costly cleanup efforts in the future.

PURPOSE

To provide the DoD with non-toxic small caliber combat ammunition which will meet U.S. and NATO performance standards for all calibers (5.56MM, 7.62MM, and 9MM). The focus will be on eliminating toxic components in the projectile core, primer, and manufacturing process. The USAEC has provided funding in support of eliminating toxic components from the projectile core.

BENEFITS

This program will revolutionize small caliber ammunition. This next generation ammunition, while benign to the environment, will have potentially enhanced lethality and functionality. Environmental restrictions on training our Warfighters will be eliminated. Training realism and effectiveness will be greatly enhanced, while eliminating all future cleanup costs. Futhermore, DoD will be the international leader in these technologies and the environmental stewardship shown will enhance both public image and trust. This program will develop a non-toxic cartridge that will eliminate the environmental and hazardous effects that are associated with current ammunition. In addition, the need for costly range cleanups will be eliminated without sacrificing the proficiency and readiness of Armed service personnel.

TECHNOLOGY USERS

U.S. Army Armament Research Development & Engineering Center, Small Caliber Ammo Branch (ARDEC)

U.S. Army Infantry Center (USAIC)

U.S. Army Research Laboratory (ARL)

Naval Weapons Support Center-Crane (NSWC)

Naval Air Warfare Center- China Lake

U.S. Air Force Security Police Agency (AFSPA)

Department of Energy(DOE)-Oak Ridge National Laboratory (ORNL)

DOE - Los Alamos National Laboratory (LANL)

DOE - Kansas City Facility (KCF)

BACKGROUND

Lead in soil, sediments, surface, and groundwater has been confirmed through investigations conducted at Army, Navy, Marine Corps, and Air Force small arms ranges throughout the United States and Europe. Lead uptake studies in vegetation at a Marine Corps range in Quantico, Virginia showed lead levels as high as 23,200 ppm. Remediation has proven to be extremely expensive. Furthermore, inspections of National Guard indoor ranges during 1986 to 1988 resulted in 812 ranges being shutdown due to high levels of contamination, both surface and airborne, and require costly renovations to meet EPA and OSHA standards. 689-million rounds of small arms ammunition, .22 caliber through .50 caliber, are fired annually during DoD training with an additional 10-million rounds fired annually

by the DOE. The amount of heavy metal introduced into the environment from this training is approximately 3-million pounds per year.

The lead projectile cores and lead compounds used in the primers create dust and fumes when fired. Shooters and range operators are exposed to dangerously high airborne lead levels. The Army Environmental Hygiene Agency, now the Army Center for Health Promotion and Preventive Medicine, has conducted studies at firing ranges which indicate that projectiles account for 80% of airborne lead released while the remaining 20% is a result of primer combustion. The studies also indicate that 40% of inhaled lead is dissolved in the bloodstream and 10% is absorbed directly by the body. Once in the body, lead is very difficult to remove.

DESCRIPTION

The Joint Non-Toxic Working Group was established in 1995 by ARDEC as a multi-service cooperative forum of DoD, DOE, private industry and academia experts. ARDEC is responsible for overall program management and execution.

USAEC has provided funding in support of eliminating toxic components from the projectile core. This focus is due to the lead build-up from rounds in small arms range impact areas resulting in non-compliance with environmental laws and regulations. Efforts to occur in concert with the USAEC initiative will include 1) downselection, optimization, and demonstration of a non-toxic percussion primer, 2) demonstration of non-toxic ammunition producibility, and 3) demonstration of replacement materials and production methods for paints, coatings, lubricants, degreasers, and sealants for the small caliber ammunition. The demonstrated products will meet all tactical and economic requirements without introducing toxic materials to the environment at any point in their life cycle.

The next generation of small arms projectiles relies on innovative material usage to reproduce and improve upon the physical, ballistic and mechanical properties of lead. Composite materials such as metal powders in nylon, or high density metal particulates bonded together with light metals, are currently being examined to produce non-toxic replacements for lead.

Concurrent with the USAEC funded demonstration of a 5.56MM Non-Toxic Projectile Alternative, other efforts will target the toxic components in the cartridge primer and manufacturing process. A cost-effective producibility demonstration of non-toxic small caliber ammunition will also be performed.

Of primary concern at outdoor ranges is the introduction and dispersion of tungsten throughout the environment. Development of the toxicity and environmental recovery information to support recycling or closed-loop use of the materials, and environmental effects are being determined. Additional leaching, environmental corrosion, and biological up-take tests will be performed to fully define stability and mobility characteristics. Study results will guide projectile formulation such that all materials will be stable and recoverable. Projectile design, constituent materials, and processing will be optimized to support the maximum recovery and recyclability of this next generation of projectile materials. USAEC will specify recovery and recycle methods and provide for the pilot scale demonstration. Adequate information regarding the use, release, and mobility of the high density constituents under consideration, specifically tungsten, is considered crucial for acceptance.

Initial non-toxic primer testing will be performed with optimized versions of both candidate materials. Downselection will occur if one material is found to be significantly superior to the other. Otherwise, it is desired to perform an extensive characterization and demonstration effort, to include qualification testing, on both temperatures and humidities. Each of these materials differ markedly from conventional primer mixes and explosives, and each can be tuned for desired

performance. The Metastable Interstitial Composites (MIC) materials as engineered energetics are many orders of magnitude faster than traditional mixtures of the same reactants. The MIC composition identified for use in this demonstration is a stoichiometric mixture of aluminum and nitride combustion. The reactants and products of both candidates are non-toxic and environmentally benign. The materials' tunability suggests that substantial improvements in percussion-primed ammunition cartridge action time is possible.

Demonstrating the producibility of the non-toxic projectile and primer is as critical as the performance demonstrations. If the items cannot be produced in a cost effective, environmentally compliant fashion, then the technology will fail. LCAAP is the Army's principal supplier of small caliber ammunition. The producibility testing of the non-toxic projectile and primer proposed above will be performed at LCAAP. Additionally, other environmental issues regarding production methods, machinery, and support materials for small caliber ammunition manufacture will be addressed. Demonstrating these methods is required. Following demonstration of the non-toxic projectile and primer as well as these processes, the technologies will be transitioned to the Green Ammunition Flexline (GAF) Program for implementation. The GAF program is funded from FY97 though FY03.

Producibility testing will be used to minimize production costs and provide feedback to the projectile and primer designs. Production rates of 1200 items/minute requires special consideration in item design and manufacture. Performing producibility testing will assure that item unit costs stay within 10% of current ammunition production costs. Additionally, areas where replacement materials and/or manufacturing process modifications can be demonstrated include 1) paints and coatings, 2) blank cartridge tip sealant, 3) primer lacquer, 4) primer pocket sealant, 5) metal forming lubricants, 6) tip degreasing, and 7) the general manufacturing equipment cleaning. DOE-KCF will optimize replacement configurations and the associated demonstrations will occur at LCAAP. The effort to demonstrate a casemouth sealant replacement is already underway. In addition, funding will be sought from other sources in order to accomplish the replacement of these materials.

Future plans for USAEC program funding will provide for Qualification tests and Type classification of the new toxic-free 5.56MM cartridge for full army-wide implementation. At the start of Phase II, the composite materials identified in Phase I will be refined to eliminate any deficiencies. Approximately 100,000 slugs of the successful candidates from Phase I (i.e. Tungsten/Nylon and tungsten/Tin) will be purchased from Texas Research Institute and Powell River Laboratories, Inc., respectively. A task order contract will then be prepared for LCAAP for the assembly and loading of M855 cartridges using the composite projectile slugs. A quantity of cartridges from each lot will be subjected to standard production verification testing to ensure the cartridges' safety and performance. All cartridges will then be shipped to Aberdeen Proving Ground for Qualification Testing.

TECOM Qualification Test requirements and ammunition quantities will be finalized. Testing will be conducted in an order such that those tests not conducted during Phase I which have the highest likelihood of revealing projectile related deficiencies will be conducted first. Some of these tests will include environmental conditioning (hot and cold temperature cycling), rough handling, and barrel erosion. These tests will be used to further downselect to one material candidate. The remainder of the TECOM testing will include, but not be limited to: Electronic Pressure, Velocity and Action Time, Dispersion, and Penetration. In the event that both candidates meet all requirements, the result will be two qualified alternate materials instead of one. During Phase III, the technology will be transitioned to the 7.62MM and the 9MM projectiles and demonstration/ testing of

those configurations will be performed. Concurrent with the manufacture and testing activities, a Corrosion and Life Cycle Cost Analysis will be performed for all three calibers. This effort will examine product cost from raw material processing, through manufacture, use, and eventual disposal and/or recycling.

APPLICABILITY

Andrulis Report Requirements:

- 3.1.c Heavy Metals Reduction/Eliminationfrom Surface Protection
- 3.3.b Reduce Hazardous Components in Ordnance
- 3.3.g Eliminate Lead in Ordnance
- 2.5.3 Eliminate Indoor Firing Range Lead Contamination
- 3.1.g Develop Alternative Sealants Materials and Technologies
- 3.3.c Reduce VOC's in Ordnance Manufacture and Analysis
- 3.1.6.c Energetics Production Pollution Prevention (Navy)
- 95-2502 Remediate Lead at Outdoor Ranges (Air Force)

ACCOMPLISHMENTS AND RESULTS

During Phase I, USAEC in conjunction with ARDEC demonstrated the viability of seven different non-developmental item (NDI) formulations to replace lead in the 5.56MM projectiles. These preliminary tests were funded to USAEC. Composite materials tested during Phase I consisted of tungsten bonded together with light metals (i.e. tin, zinc) or synthetics (i.e. nylon). Composites were subjected to a high speed assembly and loading process to produce net shape cores with physical properties similar to lead. Projectiles underwent ballistics performance testing for dispersion, penetration, electronic pressure, velocity, and action time. Phase I successfully isolated two candidates suitable for replacing the current 5.56MM service round. Toxicity studies on tungsten are currently being analyzed at Oakridge National Laboratories.

POINT OF CONTACT

Lisa Miller

PROGRAM PARTNERS

U.S. Army Environmental Center

Partners for the USAEC's funded projectile core replacement:

U.S. Army Armament Research Development and Engineering Center

Lake City Army Ammunition Plant

Oak Ridge National Laboratory

Joint Small Arms Range Remediation

Many small arms ranges have soils that contain lead, a RCRA listed toxic material. Conventional cleanup technologies are limited to stabilization and land filling. Physical separation and soilwashing are cost-effective technologies that will remediate soil to an appropriate level, reduce waste volume, minimize range downtime, and eliminate future liability to DoD.

PURPOSE

To provide for the full scale demonstration and evaluation of the family of physical separation and soil washing technologies for the removal of lead from small arms firing range soils.

BENEFITS

A cost effective technology for the cleanup and maintenance of small arms firing ranges will be available throughout the Army.

TECHNOLOGY USERS

All DoD small arms ranges.

BACKGROUND

Numerous Department of Defense (DoD) sites exist with soils that contain lead or other heavy metals due to use as small arms testing and practice ranges. Small arms projectiles consist primarily of lead, which is a RCRA listed toxic material. Recent DoD facility closures have focused attention on the toxic lead build up at the small arms facilities resulting in the classification of the abandoned small arms ranges as solid waste management units. In addition, future regulatory focus may restrict test and training activities and force the closure of valuable small arms range facilities. As a result, the Army user community has prioritized the problem "Soil Inorganic" as the seventh highest requirement in the area of environmental restoration research and development. The conventional cleanup technologies for lead contained in soil are limited to landfilling and solidification/stabilization. These technologies are expensive and do not destroy or remove the toxic metals. As disposal restrictions become tighter, these methods will become increasingly more difficult and expensive. Current costs for treatment are in the range of $300 per ton. Mileage from the remediation site to the nearest disposal facility typically exceeds 600 miles one way. Excessive waste transportation increases both the disposal costs and the potential for accidents. Ultimately DoD long term liability for these wastes remains due to the fact that current technologies do not remove metal contaminants. The future environmental risk to DoD remains high. As a result, the need for an alternative technology is particularly urgent at Base Realignment and Closure sites with small arms ranges.

DESCRIPTION

A true destruction technology does not exist and can not be developed for soils that contain lead and other heavy metals. Physical separation technologies however, provide for the separation of the metals from a large fraction or whole of the soil material. Typically, metals are concentrated in the fines fraction of soils. Isolation of the fines fraction removes most of the metals from the majority of the soil. This will result in a significant reduction in the volume of soil requiring landfilling or stabilization. The clean soil fraction can be backfilled and no further treatment of that fraction will be required. The fines fraction, if concentrated adequately, can be recycled to a smelter allowing for total recycle of the metal. Such treatment techniques will eliminate the hazard completely and thus no liability to DoD will remain. The U.S. Army Environmental Center (USAEC) and the Naval Facilities Engineering Services Center (NFESC) conducted a joint demonstration of combined physical separation/soilwashing processes for the

removal of heavy metals from firing range berm materials at Fort Polk, Louisiana. The Waterways Experiment Station (USAWES) provided optimized process parameters, treatability data, and design parameters for the demonstration from their completed SERDP funded effort. Upon completion of a treatability study, two commercial vendors were selected to demonstrate their soil washing/acid leaching technologies. The vendors installed and operated their equipment on site for a period of 5 months. Two acid leaching technologies were demonstrated, one using hydrochloric acid and the other, acetic acid. Each vendor was required to reduce lead levels in the soil to 500 ppm and pass the Toxic Characteristic Leaching Procedure (TCLP) at 5 ppm soluble lead.

USAEC had the overall responsibility for the preparation of the site and conduct of the demonstration. The NFESC was responsible for the analysis, documentation, and independent evaluation of the demonstration. At the conclusion of the hydrochloric acid demonstration, concentrated wastes were sent to a local smelter for recycle. Data collected included influent and effluent concentrations, cost of equipment and resources, operational and maintenance costs, and all other pertinent information. All information, including a cost/benefit analysis will be documented in a final report to be completed by June 1997.

APPLICABILITY

Andrulis Report Requirements:

- 1.3.e Soil Inorganic
- 1.4.c Heavy Metal

RCRA

Clean Water Act

National Pollution Discharge Elimination System (NPDES)

ACCOMPLISHMENTS AND RESULTS

The demonstration was held at Ft. Polk, LA. Both technologies (weak acid and strong acid) have been demonstrated. Demobilization of the second vendor is complete and the demonstraton site is restored according to Ft. Polk specifications. A post-demonstration meeting was held on 23 January 1997 to review progress to date and coordinate preparation of end deliverables. The hydrochloric (strong) acid technology demonstrated the highest performance of the two technologies with a mean TCLP level of 2.0 ppm and a mean total Pb of 171 ppm.

LIMITATIONS

This process might not treat soils high in clay content or that contain contaminants such as mercury or certain organic compounds.

RESOURCE SUPPORT

ESTCP

FOLLOW-ON PROGRAM REQUIREMENTS

This full-scale demonstration of physical separation and soil-washing technologies may provide an effective treatment for lead in small-arms firing ranges. USAEC and NFESC will use validated data on the cost and effectiveness of this demonstration with implementation and design guidance to explain this technology to users.

The approach will accelerate the demonstration and transfer of soil separation and washing technologies for remediation of small-arms firing ranges.

POINT OF CONTACT Lisa Miller

PROGRAM PARTNERS U.S. Army Environmental Center

Naval Facilities Engineering Service Center

U.S Army Corps of Engineers Waterways Experiment Station

Ft. Polk, LA

PUBLICATIONS The Technology Application Analysis , the Implementation Guidance Manual, Pamphlets and Videos will be available in May 1997.

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Shock Attenuation Concrete Performance and Recycling Demonstration / Soft Concrete Berm Demonstration

Recovery of lead and other bullet fragments from conventional soil berms is often difficult. As a result, lead and other heavy metals may leach into the groundwater, resulting in a potential remediation effort. Impact berms constructed from a special type of concrete will stop and retain the bullets while providing an easily recycled berm material..

PURPOSE

To use Shock Attenuation Concrete (SACON) and Soft Concrete Berm to reduce the potential of off-site migration of lead and other heavy metals. To Demonstrate a soft concrete mixture to be used as a substitute for dirt as a range berm.

BENEFITS

SACON may provide a means to recycle the projectile material and prevent the build-up of heavy metals in the soil on the range. SACON would also mitigate the excessive soil erosion experienced on outdoor ranges caused by the impact of the rounds. Erosion control and soil stabilization on the ranges would help prevent the migration of existing heavy metals off range and it would help alleviate the recurring costs of land rehabilitation on the ranges. In addition, SACON may reduce or eliminate safety problems caused by ricochets off natural or other materials on current ranges. SACON bullet traps, designed to capture bullets fired into limited cross-sectional areas, are currently being developed by US Army Engineer Waterways Experiment Station (USAEWES) and may represent a feasible solution for some types of firing ranges.

TECHNOLOGY USERS

Primarily FORSCOM and TRADOC installations

National Guard, Navy, Coast Guard, Marines, and Air Force

BACKGROUND

Numerous Department of Defense (DoD) small arms ranges have the potential to build-up lead and other metals in soils. In some cases, those inorganics may become mobile and migrate to surface or groundwater. The Army currently operates approximately 1400 outdoor small arms ranges (CONUS). The Navy operates approximately 270 outdoor small arms ranges (including Marine ranges) and the Air Force operates approximately 200 outdoor small arms ranges. The US Army Environmental Center (USAEC), Army Training Support Center (ATSC) and US Army Engineer Waterways Experiment Station (USAEWES) is seeking ways to reduce the potential of off-site migration of lead and other heavy metals.

SACON has been in use as a bullet stopping material since the 1980's. It has been extensively field tested witha a wide variety of small arms, including most common military and civiian automatic and semi-automatic weapons. The Army and a number of federal and state agencies have fabrcated "training villages" from SACON. However, SACON has not been demonstrated as a berm material on conventioal small arms ranges.

DESCRIPTION

The properties of this substance are such that it is porous enough that a bullet will penetrate the concrete and be retained. Also as the berm reaches its usable life it can be removed and recycled into high strength concrete complete with the bullets still inside.

Two sites have been selected for demonstration of SACON, U.S. Military Academy (USMA) West Point, new York and Fort Knox, Kentucky. Initially

SACON will be tested on 25 Meter Zero Ranges at both sites. Additional test will be performed on Automated Record Fire (ARF) ranges at both sites and on an Automated Field Fire (AFF) range and a Combat Pistol Qualification Course (CPQC) at Fort Knox.

APPLICABILITY

Andrulis Report Requirements:

- 2.3.c Develop Recycle/Reuse Technologies
- 2.3.d Develop Alternative Technologies to Mitigate Contaminated Soil
- 4.2.i Land Rehabilitation
- 4.3.a Mitigating Army--Unique Impacts
- 4.3.d Erosion Control Technologies

ACCOMPLISHMENTS AND RESULTS

Preliminary field trials were conducted on the 25 Meter ranges at Fort Knox and West Point in Nov 96. Performance data and discussions with range personnel resulted in the decision to redesign the SACON blocks for the 25 Meter range application. The block redesign is complete and the new block molds are under construction at this time.

DESA's SACON assessment team, which is under contract to gather data and assess the performance/recyclingof SACON, completed the draft data gathering documents and forms. An initial briefing of the data collection requirements was given to the range managers at West Point and Fort Knox in Nov 1996.

The Cooperative Research and Development Agreement between USAEWES and Ballistics Technology International signed and forwarded to Corps Headquarters on 11 Dec 1996.

FOLLOW-ON PROGRAM REQUIREMENTS

- Begin field demonstrations
- Complete design of erosion control bullet traps
- Conduct SACON field casting demonstration

POINT OF CONTACT

Gene Fabian / Richard O'Donnell

PROGRAM PARTNERS

US Army Environmental Center

Army Training Support Center

US Army Engineer Waterways Experiment Station

U.S. Army Military Academy, New York

PUBLICATIONS

A manuscript for the American Defense Preparedness Association 1997 Waste Management Conference is set for publication in the Proceedings of the Meeting. The paper will be presented on 28 Jan 1997 in Portland, OR. The presentation is entitled "Management of Spent Bullets and Bullet Debris on Training Ranges."

A paper entitled "Chemical Containment of Heavy Metals from Bullet Debris in Shock-Absorbing Concrete (SACON) Bullet Barriers" has been accepted for presentation in the ADPA 23rd Environmental Symposium, to be held in New Orleans, LA in Apr 97.

Small-Arms Range Bullet Trap Feasibility Assessment and Implementation Plan

The lead from bullets fired on small-arms ranges may contaminate groundwater and soil. Such lead contamination result in long-term clean-up costs and range closure. Capturing the bullets will prevent the lead from entering the environment. Pollution prevention through the use of bullet traps on small-arms ranges will result in greater range availability for training, long-term savings, and environmental protection.

PURPOSE

The U.S. Army Environmental Center (USAEC) is seeking ways to reduce the potential of off-site migration of lead and other heavy metals to reduce the impacts on the environment and promote training readiness through pollution prevention methods which reduce environmental compliance impacts.

BENEFITS

Bullet traps may provide a means to recycle the projectile material and prevent the contamination of the range and the environment. The bullet traps would also mitigate the excessive soil erosion experienced in outdoor ranges caused by the impact of the projectiles. Erosion control and soil stabilization on the ranges would help prevent the migration of existing heavy metals contaminants off range and it would help alleviate the recurring costs of land rehabilitation on the ranges.

TECHNOLOGY USERS

All Army and DoD installations with small-arms ranges will benefit from this technology. In addition, there may be civilian applications.

BACKGROUND

Numerous Department of Defense (DoD) sites have been contaminated by lead or other heavy metals due to use as small arms testing ranges and as practice ranges. The Army currently operates approximately 1400 outdoor small arms ranges (CONUS). The Navy operates approximately 270 outdoor small arms ranges (including Marine Ranges) and the Air Force operates approximately 200 outdoor small arms ranges.

Future regulatory focus may restrict test and training activities and force the closure of valuable small arms range facilities unless methods are implemented to capture and recycle all of the projectile material and prevent contamination of the range facility and the surrounding environment. Bullets from small-arms are primarily lead, which is listed as a toxic material by the Federal Resource Conservation and Recovery Act (RCRA). Once fired, bullets may corrode and the lead may enter ground or surface water. This may result in a violation of RCRA or other laws. Clean-up of water contaminated with lead is costly, and contamination may result in range closures or restricted use.

DESCRIPTION

The collection of bullet trap usage on private and public lands for the transfer of this technology to Army/military use. Bullet traps can reduce the amount of lead and other metal compounds that presently end up in the soils of military installations. Present use of bullet traps is presently limited to only a handful of military installations and primarily confined to indoor ranges. This project will identify the best available configurations of bullet traps to be considered for use at outdoor military ranges.

Techniques that limit the volume of soil containing heavy metals at small-arms ranges also will limit cleanup costs and prevent regulatory restrictions of test and training activities at active sites. Bullet traps at training sites that capture and contain the projectiles for recycling will limit or possibly prevent soil

contamination. Demonstrations of commercially available bullet traps are being initiated.

Applicability

Andrulis Report Requirements:

- 2.3.c Develop Recycle and Reuse Technologies
- 2.3.d Develop Alternative Technologies to Mitigate Contaminated Soil
- 4.3.a Mitigating Army-Unique Impacts

Accomplishments and Results

- An evaluation of outdoor small-arms range designs has been completed to develop criteria for bullet trap implementation on the ranges.
- A technology identification search also has identified commercially available bullet traps.
- The bullet trap feasibility assessment report and user's manual are in their final drafts.
- Demonstration of commercial bullet traps on a 25 Meter range are being initiated.

Limitations

Use of bullet traps to capture lead may result in:

- Increased maintenance costs for traps
- Increased construction costs for new or refurbished ranges
- Reduced training realism in some cases
- Reduced range use flexibility for the user as some bullets or weapons might damage the traps

Resource Support

For FY96, this program was supported by the USAEC.

Follow-On Program Requirements

After project members complete the feasibility study and identify candidate bullet traps, a pilot demonstration location may be required.

Point of Contact

Gene L. Fabian

Program Partners

Army Environmental Center

Army Training Support Center

Publications

Final Report, Bullet Trap Feasibility Assessment and Implementation Plan, Technology Identification Report, March 1996, Report Number SFIM-AEC-ET-CR-96005.

Final Report, Bullet Trap Feasibility Assessment and Implementation Plan, Evaluation Criteria Report, April 1996, Report Number SFIM-AEC-ET-CR-96142.

Final Report, Bullet Trap Feasibility Assessment, December 1996, Report Number SFIM-AEC-ET-CR-96195.

Final Report, Bullet Trap User's Guide, December 1996, Report Number SFIM-AEC-ET-CR-96201.

UNEXPLODED ORDNANCE

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Subsurface Ordnance Characterization System

Areas on military installations with subsurface ordnance or UXO are often difficult to return to full use for training as locating, characterizing and removing the ordnance is difficult. Evaluating systems which perform these tasks is difficult as there is often no baseline to measure system performance against.

PURPOSE

To establish Subsurface Ordnance Characterization System (SOCS) as a reliable, robust, testbed system for conducting scientific studies during limited site investigations.

BENEFITS

The identification of more safe, effective and economical methods for Unexploded Ordnance (UXO) location and identification.

TECHNOLOGY USERS

All DoD sites containing areas of UXO.

BACKGROUND

SOCS is a testbed system that is being used to evaluate new technologies and conduct scientific field studies to identify more safe, effective and economical methods for UXO location and identification.

DESCRIPTION

Planning Research Corporation, Environmental Management Incorporated PRC EMI will perform a complete system assessment of SOCS. The system assessment report will provide the Government with information necessary to identify system improvements and upgrades (short and long-term) that will improve the durability and reliability of SOCS when conducting field studies of different sensors and sensor combinations; data acquisition and reduction of techniques; geophysical phenomena; and autonomous surveying methods and parameters.

The second stage is to characterize and evaluate a new antenna design for detecting buried UXO with Ground Penetrating Radar (GPR). The GPR investigation will focus on evaluating and demonstrating a new, lightweight design that has improved performance over the current SOCS GPR subsystem.

APPLICABILITY

Andrulis Report Requirements:

- 1.1.d UXO Identification
- 1.3.f Soil UXO
- 1.3.1 Establish Cleanup Standard for UXO

ACCOMPLISHMENTS AND RESULTS

The system is integrated and functioning.

ESTCP demos completed at Tyndall and Jefferson Proving Ground (JPG).

Successful autonomous surveying.

Positive results with GPR discrimination.

LIMITATIONS

Poor system reliability and durability.

Magnetometers limited to existing capabilities.

Resource Support

The DERA program provided support for this project.

Follow-On Program Requirements

SOCS will be used in conjunction with the Phenomena Study for UXO Detection.

Field Demo at a site TBD.

The following studies will be performed to improve site characterization:

- Improve existing sensor capabilities
- Evaluate new sensors & combinations
- Investigate geophysical effects on performance
- Evaluate discrimination techniques

Characterize system operating parameters.

Point of Contact

Scott Hill

Program Partners

U.S. Army Environmental Center

Jefferson Proving Ground, Indiana

Naval Explosives Ordnance Disposal Technical Division

Tyndall Air Force Base, Florida

Wright Lab

UXO Clearance Technology Demonstration Program

The current methods of UXO characterization and the clearance are not acceptable. Additional technology and methodology must be developed and evaluated for economical and timely site restoration.

PURPOSE

To identify , assess and enhance the state-of-the-art in UXO detection, identification, and remediation technologies.

BENEFITS

- Address high priority user needs.
- Evaluates capabilities of commercially available and government UXO technology.
- Establishes performance baselines.
- Performs technology transfer.
- Educates government and contractor representatives, researchers, site managers, policy makers and regulators about UXO.

TECHNOLOGY USERS

All DoD installations containing areas of UXO.

BACKGROUND

In recent years the Department of Defense (DoD) has experienced an increase in environmental compliance and cleanup activities. Unexploded Ordnance (UXO) is one of these environmental concerns. The UXO exists at DoD-owned properties and formerly used defense sites and is largely the result of weapon system testing and troop training activities conducted over the past century. The variety and extent of unexploded munitions present a challenge which requires the application of advanced technology for cost-effective, accurate and reliable UXO characterization and remediation capabilities and solutions.

The U.S. Army Environmental Center (USAEC), for many years, has been working toward enhancing technological capabilities (largely in partnership with the commercial sector) and ensuring these technologies, methods, and services are understood and readily available to the governmental market. The USAEC's integrated UXO Technology Demonstration and Technology Transfer Program seeks to accomplish these objectives, while leveraging DoD's limited UXO technology development, test, and evaluation resources.

DESCRIPTION

The UXO Technology Demonstration and Transfer Program, identifies and evaluates innovative and cost-effective technologies for UXO detection, identification, and remediation.

APPLICABILITY

1) Andrulis Report Requirements:

- 1.1.d UXO Identification
- 1.3.f Soil UXO
- 1.3.1 Establish Cleanup Standard for UXO

2) General Officer Steering Committee on UXO - Report to Congress

ACCOMPLISHMENTS AND RESULTS

As part of the overarching UXO Technology Demonstration and Technology Transfer Program, USAEC established (upon Congressional direction) the UXO Advanced Technology Demonstration (ATD) Program. This comprehensive ATD

Program, was conducted over the past three years at Jefferson Proving Ground (JPG), Illinois Phase I, II and III) and five live ordnance sites across the country, reports numerous accomplishments. The ATD Program:

- identified and evaluated numerous commercially available systems for UXO site characterization and remediation,
- established technology performance baselines,
- progressively monitored state-of-the-art UXO technology advancements, and
- drove the commercial sector to perform internally funded research and development efforts to better meet government needs.

The JPG Phase I-III ATDs were conducted at a controlled test site which contained numerous types of inert ordnance, precisely located at various depths and orientations, while the Live Site ATDs were conducted at five sites across the U.S. which contained live ordnance. Commercial companies were invited to demonstrate their system's ability to detect, characterize or remotely excavate UXO.

To date, over 60 technologies have been demonstrated and evaluated as part of the ATD Program. The demonstrators represented airborne , ground vehicle, and man-portable platforms; magnetometer, ground penetrating radar, electromagnetic induction, and infrared sensors; target process software; and excavation technologies.

ATD performance results have shown ordnance detection capabilities ranging from 0-85%. JPG Phase III results, to be published in April 1997, once again indicate increased detection performance. UXO detection technology, however, continues to exhibit extremely high false alarm rates and minimal or no discrimination ability (the ability to discriminate between UXO and other objects such as shrapnel, metal debris, etc. that are abundantly found at typical UXO sites).

LIMITATIONS

Although currently available commercial technological capabilities approach a level of acceptability for UXO detection (greater than 90%), the inordinate numbers of false alarms (and the corresponding lack of discrimination ability) will result in disprudent site remediation decisions.

FOLLOW-ON PROGRAM REQUIREMENTS

Congress directed that a JPG Phase IV effort be initiated during 1997. The JPG Phase IV effort will capitalize upon the previous UXO technological investments by concentrating on areas which are most needed (requirements driven process) and will show the greatest return for the resources applied. Not only have the previous year ATDs been examined, but the lessons learned from the USAEC Defense Environmental Restoration Account Programs, Environmental Security Technology Certification Programs, and outside agency projects, are being reviewed. The Phase IV effort will directly focus upon the critical area of target discrimination and reduction of false alarm rates. This will provide the government with economical and effective technology that will significantly reduce the overall cost of UXO clearance (by reducing the number of anomalies which must be excavated).

POINT OF CONTACT

Kelly A. Rigano

PROGRAM PARTNERS

U.S. Army Environmental Center

Naval Explosive Ordnance Disposal Technical Division

PUBLICATIONS

Report No. SFIM-AEC-ET-CR-94120, Unexploded Ordnance Advanced Technology Demonstration Program at Jefferson Proving Ground (Phase I), December 1994.

Report No. SFIM-AEC-ET-CR-95033, Evaluation of Individual Demonstrator Performance at the Unexploded Ordnance Advanced Technology Demonstration Program at Jefferson Proving Ground (Phase I), March 1995.

Report No. SFIM-AEC-ET-CR-96170, Unexploded Ordnance Advanced Technology Demonstration Program at Jefferson Proving Ground (Phase II), June 1996.

Report No. SFIM-AEC-ET-CR-96171, Live Site Unexploded Ordnance Advanced Technology Demonstration Program, June 1996.

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WATER and WASTEWATER

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Composting of Nitrocellulose Fines

Munitions manufacturing processes may generate nitrocellulose fines. Disposal of these fines is difficult because of their reactive nature. Composting has potential to be a safe and cost effective means of disposal.

PURPOSE

To demonstrate composting as an environmentally acceptable method to render Nitrocellulose (NC) fines inert.

BENEFITS

A safe and environmentally acceptable method to dispose of Nitrocellulose fines. Composting has been shown to render NC fines inert and result in a useful soil amendment. Incineration is not required.

TECHNOLOGY USERS

Army ammunition plants.

BACKGROUND

Open Burning is no longer permitted in several states and is expected to banned nationally in the future. Open detonation is also the least acceptable form of disposal because of uncontrolled pollution by-products. In its role as the DoD Manager for conventional munitions, Army must be able to dispose of Propellants/Explosives/Pyrotechnics production wastes.

Regulatory requirements for the disposal of nitrocellulose fines are undefined. NC fines are not toxic substances, but they are reactive. In order to dispose of NC fines, their reactivity needs to be reduced. Composting is an approach which is being studied as a potential method to render NC fines inert.

DESCRIPTION

In composting, a controlled biological process, microorganisms convert biodegradable hazardous material to innocuous, stabilized by-products, typically at elevated temperatures between 50 - 55 °C. The increased temperatures result from heat produced by the microorganisms as they degrade the organic material in the waste. The NC fines are mixed with bulking agents and organic amendments, such as wood chips and animal and vegetable wastes, to enhance the porosity of the mixture. Maintaining moisture content, pH, oxygenation, temperature, and the carbon-to-nitrogen ratio achieves maximum degradation efficiency.

Composting offers an alternative treatment technology for:

- Remediation of soils contaminated with NC fines
- Disposal of NC fines stored at Army facilities
- Disposal of NC fines generated from the production of nitrocellulose

APPLICABILITY

Andrulis Report Requirements:

- 1.3.a Remediation of Explosives in Soil
- 1.3.m Soil Bioremediation
- 2.2.a Develop Treatment Technologies for Wastewaters from Munitions Production
- 2.3.a Alternatives to OB/OD

ACCOMPLISHMENTS AND RESULTS

An evaluation of various options for recovering, treating and disposing of nitrocellulose in the manufacturing wash streams at Radford Army Ammunition Plant (RAAP), Virginia, indicated that biological treatment may provide a feasible

disposal alternative for NC fines wastes.

A field demonstration at Badger Army Ammunition Plant, Wisconsin, determined that composting can successfully biologically degrade the NC in soils contaminated with NC-based propellants. Significant progress also has occurred in the development of composting to remediate soils containing explosives.

Viable compost mixtures have been identified that include the necessary biodegradable substrate and bulking agents to promote microbial metabolic activity for the degradation of NC fines.

A safety hazards analysis of the NC fines/compost mixtures has been performed to determine the quantity of NC fines that can be placed in a compost pile and avoid flame and shock propagation. Sensitivity testing has been performed to determine the response of various NC fines concentrations and amendments to impact, friction, and electrostatic discharge.

The regulatory requirements associated with disposal of composted fines have been evaluated as well as the logistics and economic feasibility of NC fines compost disposal. Based on the regulatory and logistics assessments, composting of NC fines is feasible. It is more expensive than other potential methods of disposal. Further investigation of less expensive methods of NC fines disposal should be investigated prior to demonstration of composting.

LIMITATIONS

- Composting NC fines is feasible, however it is more expensive than other potential methods of disposal.
- Composting requires substantial space.
- Composting increases the volume of material because of the addition of amendment material.
- Prior analytical methods used to determine the NC fines content in the compost produced disputable results.
- A definitive analysis method is not currently available.

FOLLOW-ON PROGRAM REQUIREMENTS

Further investigation of less expensive methods of NC fines disposal should be investigated prior to demonstration of composting.

POINT OF CONTACT

Gene Fabian

PROGRAM PARTNERS

U.S Army Environmental Center

Badger Army Ammunition Plant, Wisconsin

Radford Army Ammunition Plant, Virginia

PUBLICATIONS

Technical report, Engineering/Cost Evaluation of Options for Removal/Disposal of NC Fines, USATHAMA Report AMXTH-TE-CR-87134, September 1987.

Technical report, Field Demonstration-Composting of Propellants Contaminated Sediments at the Badger Army Ammunition Plant (BAAP), USATHAMA Report CETHA-TE-CR-89061, March 1989.

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Technical report, Composting of Nitrocellulose Fines - Regulatory and Logistical Feasibility - BAAP Installation, USAEC Report Number SFIM-AEC-ET-CR-95087. December 1995.

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Oil - Water Separation Technology

Oil/water separators at installations often fail due to inadequate maintenance, therefore rendering them ineffective. As a result, oil is not being separated through oil/water separators, thus discharging with the water. Making installations aware that operation and maintenance plans are needed will help to decrease the number of violations associated with oil/water separators.

PURPOSE

To make installations aware of the operation and maintenance involved with oil/water separators.

BENEFITS

Making installations aware of proper operation and maintenance will decrease the chance of oil/water separators being shut down due to high oil and grease concentrations in the effluent. Mission readiness will also be enhanced.

TECHNOLOGY USERS

DoD facilities using oil/water separators.

BACKGROUND

Oil/water separators are designed to separate oil and solids from water that is being discharged to a given source. However some commercially available oil/water separators cannot handle the complex military wastestream, primarily the high solid and oil grease concentrations. Also many installations do not properly maintain oil/water separators, thus rendering them ineffective. Installations need to be made aware of the necessary operation and maintenance involved with oil/water separators.

DESCRIPTION

Installations need to develop an operation and maintenance schedule with their oil/water separators. If completely malfunctioning, then new oil/water separators need to be purchased and properly maintained.

Three installations will take part in the oil/water demonstration. In this demonstration, operation and maintenance procedures will be documented. At the conclusion of the demonstration, a consumer reports "lessons learned" guide will be made available for all DoD users making them more aware of the proper operation and maintenance associated with their oil/water separators.

APPLICABILITY

Andrulis Report Requirements:

- 2.2.e Oil Water Separator Technology.
- 2.6.c. Develop Removal/Treatment Technologies for Oil and Greasy Waste
- 3.7.c. Improve Oil-Water Separation Technologies

ACCOMPLISHMENTS AND RESULTS

- Partner with USAF, USN, Army AESAP and submitted Environmental Security Technology Certification Program (ESTCP) proposal for oil/water separators evaluation.
- Survey 1995 1383's and sent Memorandum to Army users, established relationship with USAF and Tyndall AFB.
- Project Order to U.S. Army Aberdeen Test Center (USAATC), USACERL for three evaluation for oil/water separators.
- Site visit conducted to view oil/water separator modifications and upgrades in

preparation for demonstration.

RESOURCE SUPPORT

VEPP

FOLLOW-ON PROGRAM REQUIREMENTS

An oil/water separator video titled "Proper Design and Maintenance of Oil/Water Separators" produced by the Air Force Center for Environmental Excellence (AFCEE) will be supplied as a training aid.

POINT OF CONTACT

Peter Stemniski

PROGRAM PARTNERS

U.S. Army Environmental Center

U.S. Navy

Tyndall AFB

Air Force Center for Environmental Excellence

PUBLICATIONS

Selection of Design of Oil/Water Separators at Army Facilities, U.S. Army Corps of Engineers Engineering Technical Letter

Peroxone Treatment of Explosives-Contaminated Groundwater

Explosives-contaminated groundwater is a problem at many Army installations. A cost effective technology to treat this contamination is required. Current technologies do not provide destruction of the contamination. Peroxone offers an opportunity to effectively treat groundwater at low cost.

PURPOSE

To evaluate the performance and cost effectiveness of the Peroxone Advanced Oxidation Process for the treatment of explosives in groundwater.

BENEFITS

Peroxone is a destructive technology, destroying the explosives contaminant.

TECHNOLOGY USERS

DoD sites containing explosives-contaminatedgroundwater.

BACKGROUND

A number of Department of Defense (DoD) sites have groundwater that contains explosives and propellant materials and wastes. The explosives in groundwater occurs on and off the installation. The Army user community has ranked "Explosives in Groundwater" as the fourth-highest requirement in environmental restoration research and development.

The current method for treatment of explosives-contaminatedgroundwater, granular activated carbon (GAC), can be cost prohibitive depending on the extent of the contamination. Additionally, GAC does not destroy the contaminants. Processes that are more cost effective than GAC and result in the actual destruction of the contaminants are being sought for the restoration of DoD sites.

The Waterways Experiment Station (USAWES) has completed its field study at Cornhusker Army Ammunition Plant (CAAP) and design of the full-scale system has begun. The project is on schedule for completion in 1997.

DESCRIPTION

This technology derives from advanced oxidative chemistry and involves the production of hydroxyl radicals that in turn react with and destroy most organic materials. With performance and cost comparable to GAC, advanced oxidation processes have been used commercially to purify drinking water and wastewater, but not to treat explosives-contaminatedgroundwater or process water. This project is the demonstration of an advanced oxidation process for explosives-contaminated water as an alternative to using granular activated carbon adsorption as is currently done.

This project will provide a full-scale demonstration of peroxone oxidation as an effective treatment of explosives in groundwater. The demonstration should last 12 weeks on site. Data analysis, reporting and documentation will follow.

Validated data on the cost and effectiveness of this demonstration and documents explaining how to implement this technology will go to users. Researchers plan to demonstrate a 25-gpm system at three sites on Cornhusker Army Ammunition Plant, Nebraska.

APPLICABILITY

Andrulis Report Requirements:

- 1.2.a Explosives in Groundwater
- 1.2.b Organics in Groundwater
- 1.2.c Solvents in Groundwater

CERCLA

RCRA

Accomplishments and Results

System installed at Cornhusker Army Ammunition Plant and the demonstration initiated.

Preliminary cost data indicates that the peroxone process is more expensive than GAC at moderate and/or low contaminant (below 1.5 ppm) concentrations.

Limitations

System parameters need to be optimized to decrease operational costs.

Follow-On Program Requirements

The system has been designed and installed. The equipment will operate on-site for three to five months. Data collected will include influent and effluent concentrations, cost of equipment and resources, operational and maintenance costs, and any other pertinent information. A final report will include a cost analysis and all documented information. The researchers plan a follow-up effort to transfer the peroxone technology, using the data from this demonstration, with implementation and design guidelines included.

Final report will be made available.

Video and/or CD-ROM documentation to become available.

Point of Contact

Ronald Jackson

Program Partners

U.S. Army Environmental Center

Cornhusker Army Ammunition Plant, NE

U.S. Army Corps of Engineers, Omaha District

U.S. Army Waterways Experiment Station

U.S. Army Construction Engineering Research Laboratories

TRW

Phytoremediation of Explosives in Groundwater Using Constructed Wetlands

Many DoD sites have groundwater which has been contaminated with explosives. Demonstrating cost effective methods to treat this contamination will allow installations to conduct restoration using reliable, accepted, and effective processes. Phytoremediation, which is the use of plants, provides an opportunity to treat large volumes of groundwater at a lower cost. The savings can then be applied to other installation operations or restoration efforts.

PURPOSE

Current groundwater cleanup technologies, such as granular activated carbon (GAC) and advanced oxidation are labor intensive and costly. A cheaper and less labor intensive process known as phytoremediation uses plants and microbes to degrade explosives. This project is demonstrating the use of phytoremediation as an alternative technology.

BENEFITS

Benefits derived from successful wetlands phytoremediation of groundwater are destruction of organic contaminants and lower treatment costs. Wetlands capital costs are estimated to be $0.45/kgal over a 30 year life of a treatment process.

TECHNOLOGY USERS

All Army and DoD installations with explosives contaminated groundwater could benefit from this technology. Milan Army Ammunition Plant, Milan, Tennessee, is the site of the current field demonstration.

BACKGROUND

Numerous DoD sites across the country have groundwater contaminated with explosives. Current technology such as GAC, ultimately requires additional disposal. UV systems require costly capital investment as well as significant labor and utilities expenses for the life of the project. The costs of GAC and UV systems are estimated at over $3.00/kgal.

An alternative such as phytoremediation can provide lower maintenance and capital costs. Estimates for phytoremediation are $200K/acre for construction and $20K/acre for operations and maintenance.

DESCRIPTION

The EPA identified the plant enzyme nitroreductase as being able to degrade TNT. In the initial phase of the project, plants native to Tennessee which contain the enzyme were challenged with explosives contaminated water from the site. The three submerged and emergent species that best reduced TNT and RDX were selected for the second phase.

In the second phase, two distinct systems were constructed, lagoon and gravel based. The lagoon system, consisting of two cells in series, was planted with submergent species in two feet of groundwater. The groundwater will be treated by the plants, naturally occurring microbes, and sunlight. The gravel based wetland contains emergent plant species in both cells. The first cell is operated anaerobically (to degrade RDX) and the second cell is aerobic. This aerobic cell is a reciprocating wetland. Reciprocation, which is the movement of water between cell compartments, further enhances water quality.

Phytoremediation can be used as a pretreatment for other technologies or as a final "polishing" technology.

APPLICABILITY

Andrulis Report Requirements:

- 1.2.a Explosives in Groundwater
- 1.2.b Organics in Groundwater
- 1.2.c Solvents in Groundwater
- 1.2.f Alternative to Pump and Treat

ACCOMPLISHMENTS AND RESULTS

The wetlands were placed in operation in June 1996. The systems are performing as expected with the gravel based wetland having a greater effect on RDX removal. There is some reduction of process effectiveness in cooler weather. Both wetlands systems are degrading TNT.

LIMITATIONS

Use of phytoremediation in constructed wetlands may be limited by:

- Cool weather
- Time constraints
- Space requirements

RESOURCE SUPPORT

This program is supported by the DoD Environmental Security Technology Certification Program.

FOLLOW-ON PROGRAM REQUIREMENTS

This project requires continued monitoring throughout the project life.

POINT OF CONTACT

Darlene Bader

PROGRAM PARTNERS

U.S. Army Environmental Center

Tennessee Valley Authority

U.S. Army Waterways Experiment Station

PUBLICATIONS

Demonstration Plan, USAEC Report SFIM-AEC-ET-CR-95090

Batch Study, USAEC Report SFIM-AEC-ET-CR-96166

Flow Through Study, USAEC Report SFIM-AEC-ET-CR-96167

Ultraviolet Oxidation of Explosives-Contaminated Groundwater

Explosives-contaminated groundwater is a problem at many Army installations. A cost effective technology to treat this contamination is required. Current technologies do not provide destruction of the contamination. Ultraviolet Oxidation has been shown to effectively treat groundwater contaminated with explosives.

PURPOSE

To evaluate the performance and cost effectiveness of the Ultraviolet Oxidation for the treatment of explosives in groundwater.

BENEFITS

Ultraviolet Oxidation is a destructive technology, destroying the explosives contaminant.

TECHNOLOGY USERS

DoD sites containing areas of explosives-contaminatedgroundwater.

BACKGROUND

A number of Department of Defense (DoD) sites have groundwater that contains explosives and propellant materials and wastes. The explosives in groundwater occurs on and off the installation. The Army user community has ranked "Explosives in Groundwater" as the fourth-highest requirement in environmental restoration research and development.

The current method for treatment of explosives-contaminatedgroundwater, granular activated carbon (GAC), can be cost prohibitive depending on the extent of the contamination. Additionally, GAC does not destroy the contaminants. Processes that are more cost effective than GAC and result in the immediate destruction of the contaminants are being sought for the restoration of DoD sites.

The U.S. Army Environmental Center has completed an analysis of the demonstration at the Savanna Army Depot Activity.

DESCRIPTION

Ultraviolet Oxidation is an advanced oxidation process which has been demonstrated to destroy organics in water. A demonstration was conducted at the Savanna Army Depot Activity, Illinois to show the effectiveness of the ultraviolet oxidation on the groundwater.

This technology derives from advanced oxidative chemistry and involves the production of hydroxyl radicals that in turn react with and destroy most organic materials.

APPLICABILITY

Andrulis Report Requirements:

- 1.2.a Explosives in Groundwater
- 1.2.b Organics in Groundwater
- 1.2.c Solvents in Groundwater.

ACCOMPLISHMENTS AND RESULTS

Analysis following the demonstration showed that a hybrid (ultraviolet oxidation - granular activated carbon) system may provide lower costs than either system alone.

Demonstration showed that inexpensive, bench scale tests are adequate to select a ultraviolet oxidation process for full scale deployment. Pilot scale testing is not required.

LIMITATIONS

Ultraviolet oxidation is not efficient at very low concentrations of explosives (less than 1 ppm).

POINT OF CONTACT

Richard O'Donnell

PROGRAM PARTNERS

U.S. Army Environmental Center

Savanna Army Depot Activity

Washrack Recycle Treatment System Evaluation

Washracks for tactical and administrative use vehicles are often a significant consumer of water on an installation. As costs of providing water and treating wastewater increase, the water requirements for a washrack must be reduced.

PURPOSE

To field test two commercially available closed-loop washracks looking for reliability and maintainability data.

BENEFITS

At the conclusion of this project a "lessons learned" users guide will be available for all interested Army users.

TECHNOLOGY USERS

Any installation within the Department of Defense.

BACKGROUND

Many installations purchase closed-loop recycle treatment systems to end all of their water compliance problems. However, no reliability or maintainability data exist in the field concerning these systems.

Washracks at military facilities can be called upon to handle many different types of vehicles from standard automobiles to tactical vehicles like armored personnel carriers or tanks. Closed-loop washracks are becoming very popular because there is very limited discharge needed. The purpose of this project is to use an independent tester and evaluate two commercially available closed-loop systems in a military environment, testing for reliability and maintainability data.

DESCRIPTION

Closed-loop washracks are becoming very popular because there is little discharge needed. Both closed-loop washrack systems are available for purchase within the military. Both manufacturers have many different systems to fit user needs.

APPLICABILITY

No current user requirement but this project was conceived from a letter from users representing MDW, TRADOC, FORSCOM, and NGB to look into closed-loop recycling.

CWA

RCRA

ACCOMPLISHMENTS AND RESULTS

A Memorandum of Agreement between U.S. Army Environmental Center (USAEC), U.S. Army Aberdeen Test Center (USAATC), and private industry was signed for the loan of the Landa WaterMaze 7023A washrack recycle system

1995 - MDW/MACOM user request submitted to USAEC

1996 - Funds allocated, evaluation began, contract teams assembled;

- Kickoff meeting and MDW site visits;
- Completed MOA between USAEC, USAATC, and Industry for Landa unit;
- Completed test plan;
- Finished Landa evaluation and change over to RGF evaluation.

RESOURCE SUPPORT

VEPP

FOLLOW-ON PROGRAM REQUIREMENTS

- Finish the Landa system test
- Changeover to the RGF system for its 13 week evaluation
- Complete the 13 week evaluation for the RGF system
- Develop and circulate the "lessons learned" users guide
- Finish with RGF evaluation and prepare final report.

POINT OF CONTACT

Peter Stemniski

PROGRAM PARTNERS

U.S. Army Environmental Center

U.S. Army Aberdeen Test Center

U.S. Army Construction Engineering Research Laboratories

Landa Incorporated

RGF Environmental Group

Appendix

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Environmental Technology Division Team

Office of the Chief (SFIM-AEC-ET)

Name	Phone Number	E-mail
James Arnold, Jr.	(410) 612-6838	jiarnold@aec.apgea.army.mil
Melissa Seigh	(410) 612-6838	maseigh@aec.apgea.army.mil

Technology Transfer Branch (SFIM-AEC-ETT)

Name	Phone Number	E-mail
Joyce Booth	(410) 612-6857	jdbooth@aec.apgea.army.mil
Darlene Edwards	(410) 612-6866	dedwards@aec.apgea.army.mil
Edward Engbert	(410) 612-6867	egengber@aec.apgea.army.mil
Erik Hangeland	(410) 612-6857	ebhangel@aec.apgea.army.mil
Scott Hill	(410) 612-6859	sahill@aec.apgea.army.mil
William Houser	(410) 612-6869	wphouser@aec.apgea.army.mil
Kelly Rigano	(410) 612-6868	karigano@aec.apgea.army.mil
George Robitaille	(410) 612-6865	gerobita@aec.apgea.army.mil
Melissa Ruddle	(410) 612-6864	maruddle@aec.apgea.army.mil
Martin Stutz	(410) 612-6856	mstutz@aec.apgea.army.mil
Tanya Lynch	(410) 612-6862	talynch@aec.apgea.army.mil
Dennis Teefy	(410) 612-6860	dateefy@aec.apgea.army.mil
Albert Walker, Jr.	(410) 612-6863	ajwalker@aec.apgea.army.mil

Technology Demonstration Branch (SFIM-AEC-ETD)

Name	Phone Number	E-mail
Darlene Bader	(410) 612-6861	dbader@aec.apgea.army.mil
Michael Dette	(410) 612-6840	mjdette@aec.apgea.army.mil
Richard Eichholtz	(410) 612-6854	rleichho@aec.apgea.army.mil
Lou Ann Elliot	(410) 612-6842	
Gene Fabian	(410) 612-6847	glfabian@aec.apgea.army.mil
Mark Hampton	(410) 612-6852	mlhampto@aec.apgea.army.mil
James Heffinger	(410) 612-6846	jgheffin@aec.apgea.army.mil
Ronald Jackson	(410) 612-6849	rpjackso@aec.apgea.army.mil
Louis Kanaras	(410) 612-6848	lkanaras@aec.apgea.army.mil
David Lorenz	(410) 612-6844	
Kim Michaels	(410) 612-6839	kdmichae@aec.apgea.army.mil
Lisa Miller	(410) 612-6843	lnmiller@aec.apgea.army.mil
Robert Muhly	(410) 671-1280	rlmuhly@aec.apgea.army.mil
Richard O'Donnell	(410) 612-6850	rhodonne@aec.apgea.army.mil
Tony Perry	(410) 612-6855	trperry@aec.apgea.army.mil
Lee Pippen	(410) 612-6840	lmpippen@aec.apgea.army.mil
Wayne Sisk	(410) 612-6851	wesisk@aec.apgea.army.mil
Peter Stemniski	(410) 612-6853	pmstemni@aec.apgea.army.mil

Fax Number:	(410) 612-6836
DSN #:	584 - XXXX
ETD Address:	Commander U.S. Army Environmental Center ATTN: SFIN-AEC-ET(_) (Person's Name) Bldg. E4430 APG, MD 21010-5401

PARTNERS

Acronym	Major Command/Installation/Department/Agency
DDESB	Department of Defense Explosives Safety Board
DESA	Defense Evaluation Support Activity
NDCEE	National Defense Center for Environmental Excellence
USAEC	U.S. Army Environmental Center
AMC	Army Materiel Command
FORSCOM	Forces Command
TRADOC	Training and Doctrine Command
USMA	U.S. Military Academy, New York
USACE	U.S. Army Corps of Engineers
88th RSC	88th Regional Support Command
	Illinois National Guard
ALAAP	Alabama Army Ammunition Plant, AMC
ANAD	Anniston Army Depot, AMC
ARDEC	Armament Research Development and Engineering Center, AMC
ATSC	Army Training Support Center
BAAP	Badger Army Ammunition Plant, AMC
CAAP	Cornhusker Army Ammunition Plant, AMC
CCAD	Corpus Christi Army Depot, AMC
HSAAP	Holston Army Ammunition Plant, AMC
HWAAP	Hawthorne Army Ammunition Plant, AMC
IAAP	Iowa Army Ammunition Plant, AMC
INAAP	Indiana Army Ammunition Plant, AMC
JOAAP	Joliet Army Ammunition Plant, AMC
JPG	Jefferson Proving Ground, AMC
LAAP	Louisiana Army Ammunition Plant, AMC
LCAAP	Lake City Army Ammunition Plant, AMC
LEAD	Letterkenny Army Depot, AMC
MAAP	Milan Army Ammunition Plant, AMC
RAAP	Radford Army Ammunition Plant, AMC
SADA	Savanna Army Depot Activity, AMC
TACOM	Tank Automotive Command, AMC
TOAD	Tobyhanna Army Depot, AMC
UMDA	Umatilla Depot Activity, AMC
VAAP	Volunteer Army Ammunition Plant, AMC
USAATC	U.S. Army Aberdeen Test Center, AMC
USACERL	U.S. Army Construction Engineering Research Laboratories, USACE
USAESC	U.S. Army Engineering and Support Center, Huntsville, USACE
USAWES	U.S. Army Waterways Experiment Station, USACE
	Army AESAP
	Camp Bullis, Texas
	Camp Dodge, Iowa
	Fort Bliss, Texas (TRADOC)
	Fort Carson, Colorado (FORSCOM)

	Fort Drum, New York (FORSCOM)
	Fort Hood, Texas (FORSCOM)
	Fort Leonard Wood, Missouri (TRADOC)
	Fort McPherson, Georgia (FORSCOM)
	Fort Polk, Louisiana (FORSCOM)
	Fort Riley, Kansas (FORSCOM)
	Fort Rucker, Alabama (TRADOC)
	Fort Sill, Oklahoma (TRADOC)
	Ft. Belvoir Fuels and Lubricants Technology Team, TACOM
	TACOM Research, Development and Engineering Center, Fort Belvior, Virginia
	U.S. Army Research Laboratory Coatings Research Team
	Huntsville District, USACE
	Omaha District, USACE
MACOM	Major Army Command
USN	U.S. Navy
IHDIV, NSWC	Indian Head Division, Naval Surface Warfare Center
NAVEODTECHDIV	Naval Explosives Ordnance Disposal Technical Division
NFESC	Naval Facilities Engineering Service Center
	Point Magu Naval Air Weapons Station
USAF	United States Air Force
AFCEE	Air Force Center for Environmental Excellence
	Tyndall Air Force Base, Florida
	Wright Laboratories, Ohio USAF
ADPA	American Defense Preparedness Association
DOE	Department of Energy
NREL	National Renewable Energy Laboratory, DOE
ORNL	Oak Ridge National Laboratory, DOE
EPA	Environmental Protection Agency
RREL	Risk Reduction Engineering Laboratory, EPA
TVA	Tennessee Valley Authority
PaDEP	Pennsylvania Department of Environmental Protection
	Georgia Institute of Technology
	University of Delaware, Department of Civil and Environmental Engineering
	BG Products, Inc.
CTC	Concurrent Technologies Corporation (CTC)
	Finish Thompson, Inc.
	Global Environmental Solution (Alliant Techsystem Company)
ICI	ICI America
	Landa Incorporated
	PALL Aerospace
	Retech Inc.
RGF	RGF Environmental Group
	Roy F. Weston Inc.
SAIC	Science Applications International Corporation
	SESCO Inc.

	TransTechnology Inc.
TRW	TRW, Inc.

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ACRONYMS

AAR	Application Analysis Report
AESAP	Army Environmental Strategic Action Plans
AIA	Automated Ion Analyzer
AIVD	Aluminum Ion Vapor Deposition
ARPA	Advanced Research Projects Agency
ATD	Advanced Technology Demonstration
BRAC	Base Realignment and Closure
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BTU	British Thermal Unit
CAA	Clean Air Act
CARC	Chemical Agent Resistance Coating
CEM	Continuous Emissions Monitor
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	Chlorofluorocarbons
CFM	Cubic Feet per Minute
CHO	Chinese Hamster Ovary Test
CNS	chloroacetophenone, choloroform and chloropicrin
CONUS	Continental United States
CPAR	Construction Productivity Advancement Research Program, USACE
CRADA	Cooperative Research and Development Agreement
CSCT	Consortium for Site Characterization Technologies
CSM	Chemical Surety Material
CWA	Chemical Warfare Agent
CWA	Clean Water Act
CWM	Chemical Warfare Material
DENIX	Defense Environmental Network and Information Exchange
DERA	Defense Environmental Restoration Account
DoD	Department of Defense
DOT	Department of Transportation
DRE	Destruction and Removal Efficiency
DSITMS	Direct Sampling Ion Trap Mass Spectrometer
EMSL	Environmental Monitoring Systems Laboratory
EPS	Eco-Purification Systems USA, Inc.
ESOH	Environment, Safety and Occupational Health
ESTCP	Environmental Security Technology Certification Program
ETD	Environmental Technology Division
ETIP	Environmental Technology Implementation Program
FAU	Fuel Additive Unit
FRH	Fire Resistant Hydraulic fluid
FRTR	Federal Remediation Technologies Roundtable
FUDS	Formerly Used Defense Sites
GAC	Granular Activated Carbon
GAF	Green Ammunition Flexline
GC	Gas Chromatograph

GPR	Ground Penetrating Radar
HAP	Hazardous Air Pollutant
HAZMIN	Hazardous Waste Minimization
HMX	cyclotetramethylene
HQDA	Headquarters Department of the Army
IOC	Industrial Operations Command
IPR	Interim Progress Review
IR	Installation Restoration
ITAM	Integrated Training Area Management
ITMS	Ion Trap Mass Spectrometer
ITRC	Interstate Technology Regulatory Cooperation
KCF	Kansas City Facility, DOE
LIF	Laser Induced Fluorescence
LRAM	Land Rehabilitation and Maintenance
M	Molar
MCLB	Marine Corps Logistics Base
MDW	Military District of Washington
MIC	Metastable Interstitial Fluid
NAPL	Non-Aqueous Phase Liquid
NASA	National Aeronautics and Space Administration
NAWS	Naval Air Weapons Station
NC	Nitrocellulose Fines
NEPA	National Environmental Policy Act
NETTS	National Environmental Technology Test Sites
NG	Nitroglycerin
NGB	National Guard Bureau
NHPA	National Historic Preservation Act
NPDES	National Pollution Discharge Elimination System
NTIS	National Technical Information Service
NTL	National Training Location
O&M	Operation and Maintenance
OB/OD	Open Burning / Open Detonation
OSHA	Occupational Safety and Health Act
PACT	Plasma Arc Centrifugal Treatment
PAT	Plasma Arc Technology
PCB	Polychlorinated Biphenyls
PEP	Propellants, Explosives and Pyrotechnic
PI	Principal Investigator
POC	Point of Contact
POL	Petroleum, Oils and Lubricants
PPB	Parts per Billion
PPM	Parts per Million
PRC EMI	Planning Research Corporation, Environmental Management Incorporated
PRC EMI	Planning Research Corporation, Environmental Management Incorporated
QA/QC	Quality Assurance / Quality Control
RCRA	Resource Conservation and Recovery Act

RDX	cyclonite
RI/FS	Remedial Investigation and Feasibility Study
SAAP	Sunflower Army Ammunition Plant, AMC
SACON	Shock Attenuation Concrete
SCAPS	Tri-Service Site Characterization Analysis Penetrometer System
SCE	Sister Chromatid Exchange Test
SERDP	Strategic Environmental Research and Development Program
SITE	Superfund Innovative Technologies Evaluation
SOCS	Subsurface Ordnance Characterization System
SOP	Standard Operating Procedure
SSBR	Soil Slurry Bioreactor
SVE	Soil Vapor Extraction
TAAR	Technology Application Analysis Report
TC	Training Circular
TCA	Tactical Concealment Area
TCAAP	Twin Cities Army Ammunition Plant, AMC
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leachate Procedure
TDG	Thiodiglycol
TDGA	Thiodiglycol acid
TDGMA	Thiodiglycol mono-acid
TkN	Total Nutrients
TkP	Total Phosphates
TLM	Test Location Manager
TNS	Technical Needs Survey
TNT	Trinitrotoluene
TPH	Total Petroleum Hydrocarbons
UMN	University of Minnesota
UMN	University of Minnesota
USACRREL	U.S. Army Cold Regions Research and Engineering Laboratory, USACE
USARC	U.S. Army Reserve Command
UXO	Unexploded Ordnance
VENC	
VEPP	
VOC	Volatile Organic Compound